



United States
Department of
Agriculture

Forest Service

Pacific
Northwest
Region



Thirty-Second Annual Western Forest Insect Work Conference

Proceedings

PROCEEDINGS

***Thirty-Second Annual
Western Forest Insect
Work Conference***

BANFF, ALBERTA
MARCH 3-5, 1981

Not for Publication

(For Information of Conference Members Only)

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Portland, Oregon

PROCEEDINGS

THIRTYSECOND ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

Banff, Alberta

March 3-5, 1981

Executive Committee (Thirtysecond WFIWC)

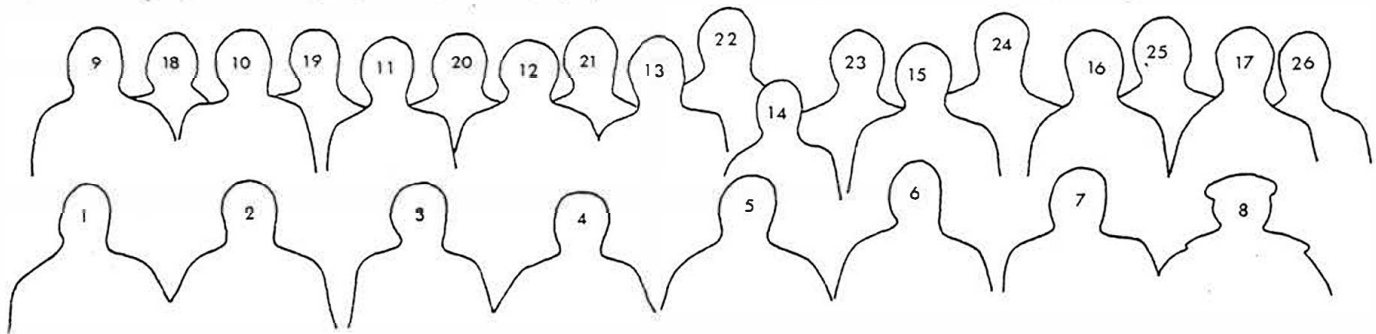
P. Buffam, Portland	Chairperson
W. Ives, Edmonton	Immediate Past Chairperson
R. Werner, Fairbanks	Secretary-Treasurer
W. Ciesia, Davis	Councilor (1978)
M. Stock, Moscow	Councilor (1979)
S. Whitney, Victoria	Councilor (1980)
J. McLean, Vancouver	Program Chairperson
R. Wong, Edmonton	Local Arrangements Chairperson

CONTENTS

Page

Program	1
Speakers, Moderators and Panelists-Affiliations	6
Executive Committee Meeting	8
Initial Business Meeting	10
Treasurer's Report	12
Keynote Address	13
Panel Summaries:	
1. What are some of the research challenges ahead?	21
2. What are the land managers' needs?	34
3. The Mt. St. Helen's eruptions and their significance to forest entomology	38
4. Are we making any progress?	39
Workshop Summaries:	
Scolytid pheromones-what now, what next?	40
How can we speed up the return of survey information to the land manager?	42
Taxonomic problems in the study of forest insect population dynamics and development of IPM systems	43
Theoretical research-what use is it?	44
Site and stand conditions, their influences on forest insect populations	*
What is required to implement and maintain a useful pest management model?	45
Lepidopteran pheromones-what next?	46
Review of current larch casebearer studies	47
Applications of remote sensing in IPM	48
Training pest managers-what are the needs?	49
CANUSA at midpoint	50
Pest management for urban trees	51
Getting a handle on forest insect dispersal	52
Local benefit-cost methods for budget constrained IPM	54
Components of pest management systems for bark beetles	56
Genetic variability of forest insect populations and implications for IPM	57
When can biological control contribute significantly to pest management?	59
Computerized integrated management systems-who'll use them?	*
Large scale aerial spraying-will we ever use them again in the west?	*
Can we adequately define the impact of grazers on forest trees?	62
Mountain pine beetle management with reference to constraints from other resource agencies	63
Seed orchard pest management	65
What new approaches will be available to the land manager in the 1980's?	66
Sampling sparse insect populations	67
Final Business Meeting	68
Treasurer's Report for Banff Conference	69
Membership Roster	70

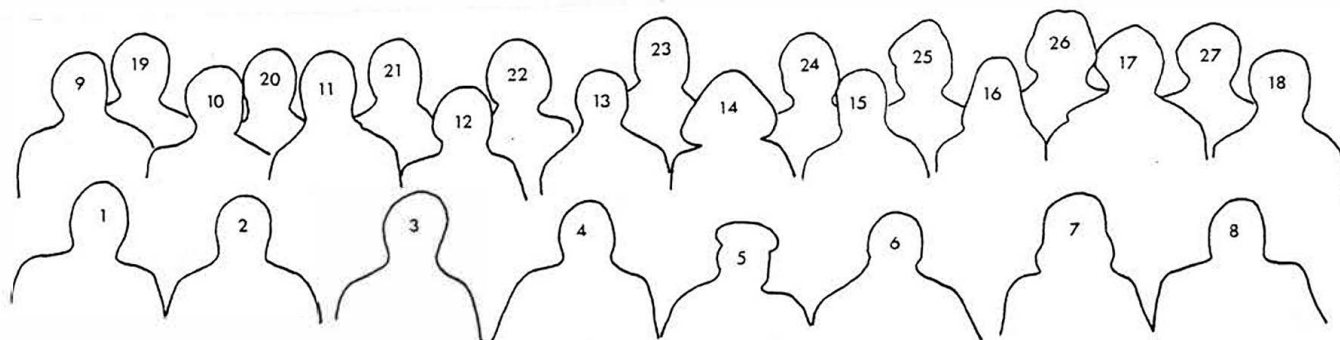
* Summary not submitted.



1. Jack Petty
2. Roy Beckwith
3. Don Burnell
4. Rene Alfaro
5. Jim Davis
6. Tony Smith
7. Bill Ives
8. Rick Johnsey

9. Dick Schmitz
10. Dick Heath
11. Ben Moody
12. Jim Cayford
13. Paul Buffam
14. Mary Ellen Dix
15. Yasu Hiratsuka
16. Ross Miller
17. Imre Otvos

18. David Schultz
19. George Harvey
20. Bob Talerico
21. Garrell Long
22. Garland Masson
23. Peter Hall
24. John Harris
25. Terry Ennis
26. Stuart Whitney



1. Karel Stoszek

2. Jack Coster

3. Terry Shore

4. Les Safranyik

5. Tom Payne

6. Richard Hunt

7. Kareen Sturgeon

8. John Laut

9. Steve Kohler

10. Bob Thatcher

11. Ken Gibson

12. Randy Randall

13. Lee Ryker

14. Laura Doliner

15. Tom Maher

16. Katharine Sheehan

17. Alan Berryman

18. Molly Stock

19. Staffan Lindgren

20. Ron Honea

21. Norman Bedwell

22. John McLean

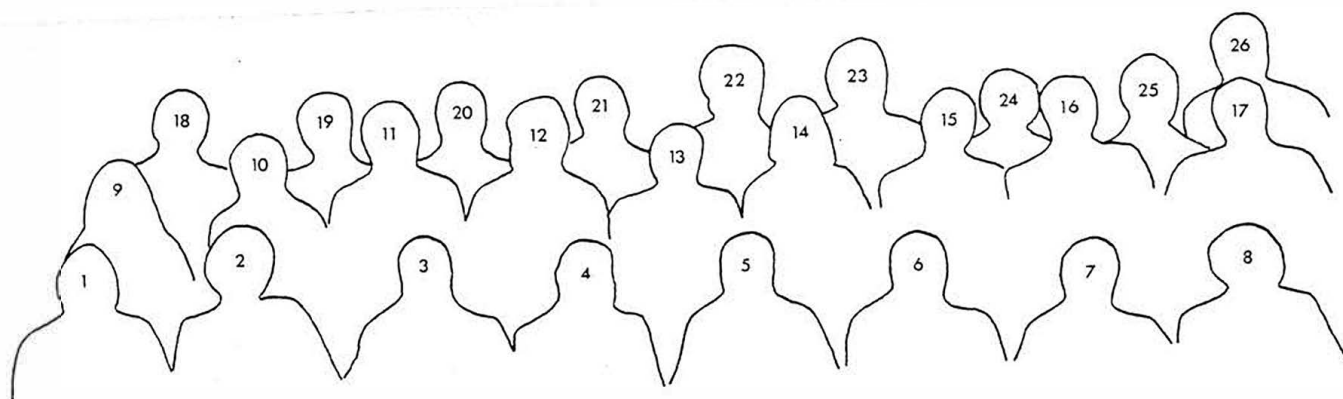
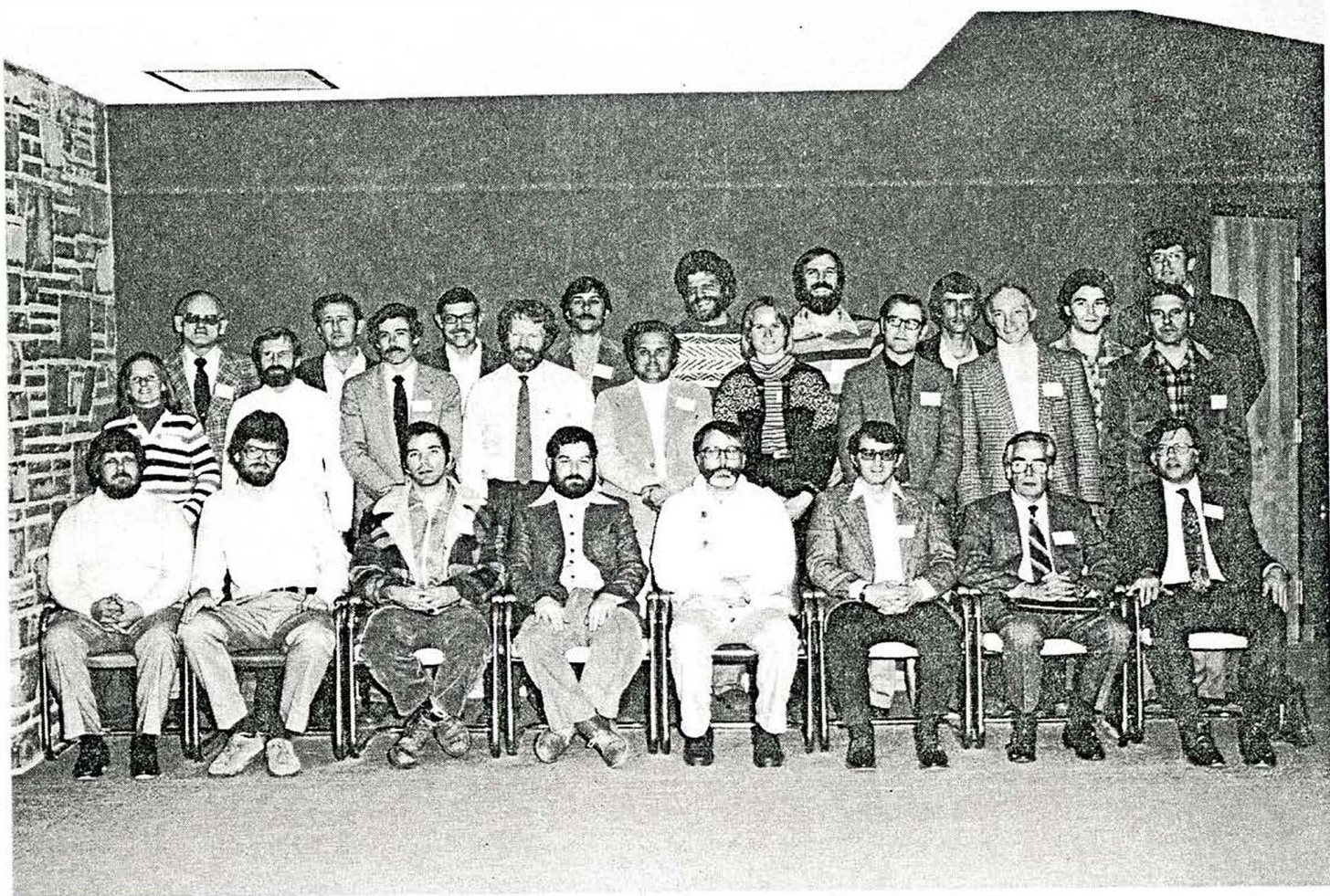
23. Evan Nebeker

24. John Dale

25. Jim Muldrew

26. Steve Laursen

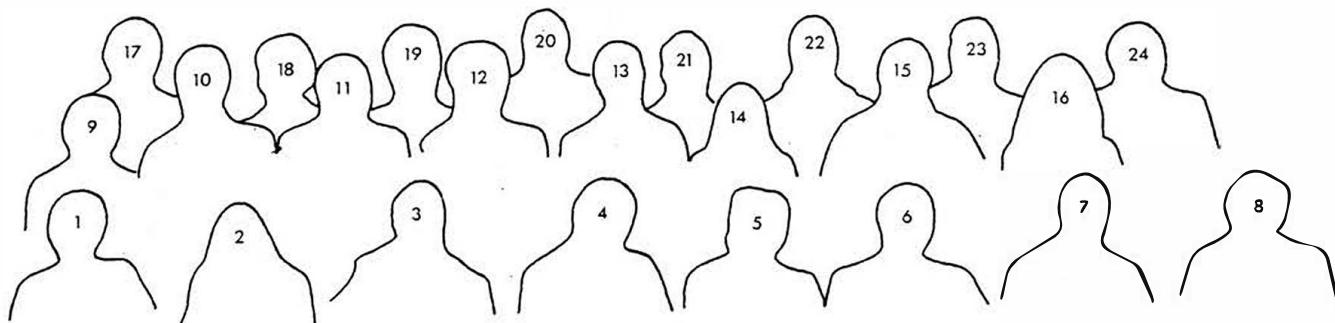
27. Mike Wagner



1. Tom Bible
2. Michael Wissenbach
3. Steve McInstosh
4. Robin Gardner
5. Woody Hart
6. Rex Cates
7. Bill Waters
8. David Wood

9. Pam Higby
10. Wayne Brewer
11. Fred Stephen
12. Don Dahlsten
13. Jan Volney
14. Ann Hajek
15. Allan Van Sickle
16. Rod Carrow
17. Dave Overhulser

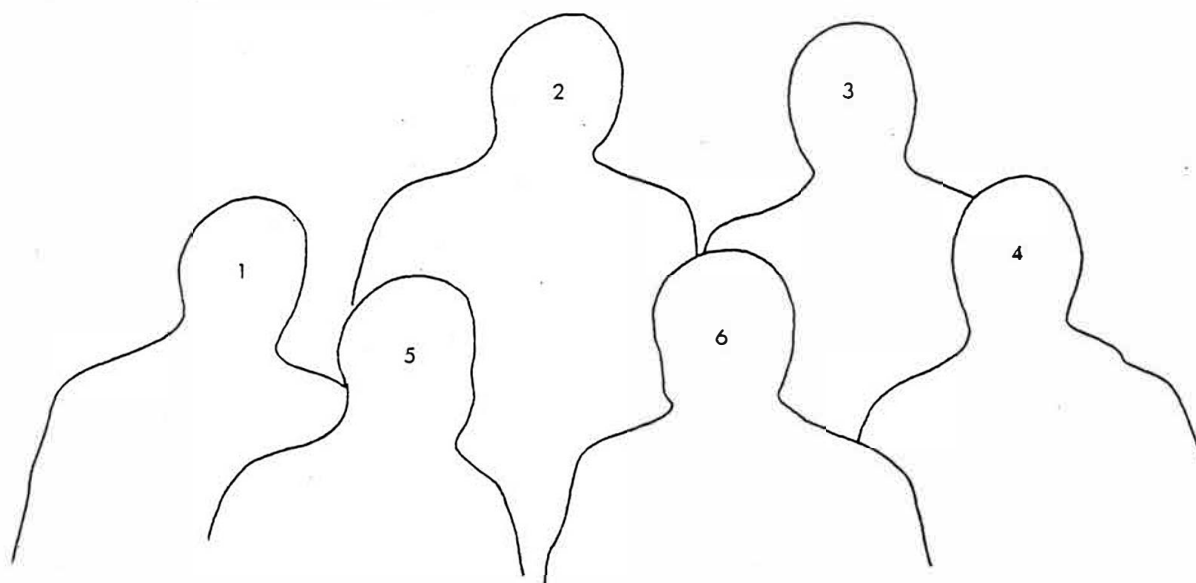
18. Ron Stark
19. Mark McGregor
20. John Foltz
21. Marc Linit
22. Richard Nathenson
23. Nick Crookston
24. Allen Robertson
25. David Gray
26. David Nielsen



1. Paul Flanagan
2. Chris Niwa
3. John DeBenedictis
4. Erick Allen
5. Sandy Liebhold
6. Herb Cerezke
7. Roy Shepherd
8. Gordon Miller

9. Bob Miyagawa
10. Mel McKnight
11. Skeeter Werner
12. Jim Colbert
13. Jim Drouin
14. Laura Merrill
15. Ron Billings
16. Dianne Szlabey

17. Bill Funkhouser
18. Gary Daterman
19. Pavel Svihra
20. Scott Tunnock
21. Tom Flavell
22. Fred Hain
23. Brodie Swan
24. Bruce Devitt



1. Randy Randall

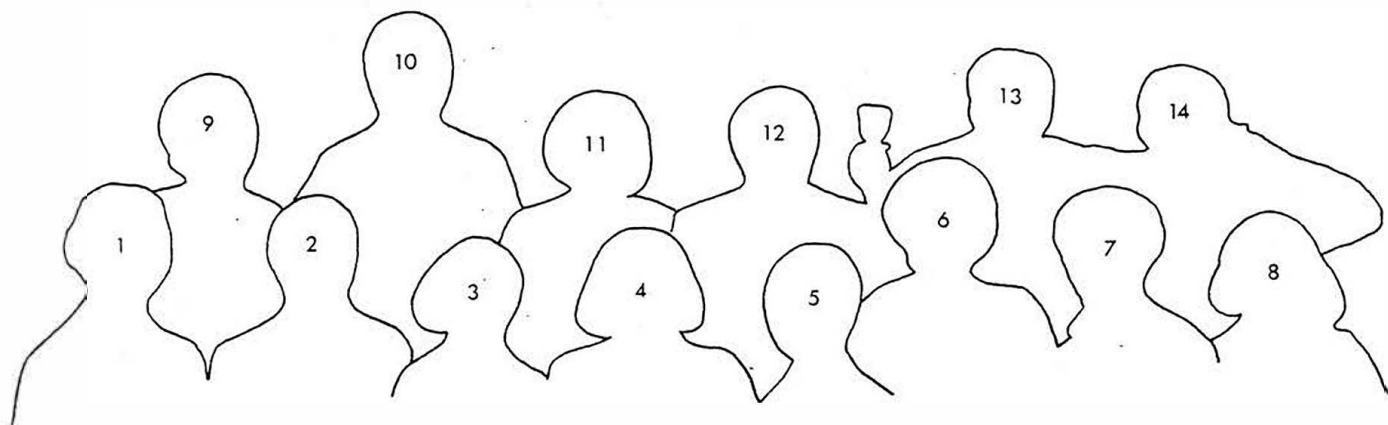
2. Dick Wong

3. Harry Johnson

4. Jim Cayford

5. Ron Stark

6. Phil Debnam



- | | |
|---------------------|-------------------|
| 1. Harriet Thatcher | 8. Margie Mason |
| 2. Laurie Stark | 9. Rene Debnam |
| 3. Agatha Johnson | 10. Boyd Wickman |
| 4. Margaret Wong | 11. Shirley Petty |
| 5. Janice Burnell | 12. Dick Wong |
| 6. Dolly Drouin | 13. Don Burnell |
| 7. Muriel Waters | 14. Tom Payne |

TECHNICAL PROGRAM

Thirtysecond Annual Western Forest Insect Work Conference

Banff Centre, Banff, Alberta

March 3-5, 1981

Monday, March 2

4:00 p.m.

Registration

8:30 p.m.

Executive Committee Meeting

Tuesday, March 3

8:00 a.m.

Registration

8:30 a.m.

Initial Business Meeting
and Conference Opening

9:00 a.m.

KEYNOTE SPEAKER: Jim Cayford

9:30 a.m.

PANEL 1: What are some of the
Research Challenges Ahead

Moderator: Don Dahlsten

Panelists: Bruce Devitt
Roy Shepherd
Tom Payne
Mel McKnight

DISCUSSION FORUM

12:00 Noon

LUNCH.

Tuesday, March 3, (Cont'd)

1:00 p.m.

CONCURRENT WORKSHOPS I:

1. Scolytid pheromones -
what now, what next? Tom Payne
2. How can we speed up the
return of survey information
to the land manager? Herb Cerezke
3. Taxonomic problems in the study
of forest insect population dynamics
and development of IPM systems.
Bill Waters
4. Theoretical research - what
use is it? Alan Berryman
5. Site and stand conditions,
their influence on forest
insect populations. Karl Stoszek

3:00 p.m.

CONCURRENT WORKSHOPS II:

1. What is required to implement
and maintain a useful pest
management model? Jim Colbert
2. Lepidopterous pheromones -
what next? Gary Daterman
3. Review of current larch
casebearer studies. Scott Tunnock
4. Applications of remote sensing
in IPM. John Harris
5. Training pest managers - what
are the needs? Don Dahlsten

4:30 p.m.

CONFERENCE PHOTOGRAPHS

Tuesday, March 3, (Cont'd)

7:30 p.m.

DISPLAY TIME - WINE AND CHEESE

1. Gadget/equipment display.
2. Book displays, reprints, prepublication exhibits.
3. Poster sessions.

Wednesday, March 4

8:30 a.m.

PANEL 2: What are the land manager's needs?

Moderator: Paul Buffam

Panelists: Peter Hall
Brodie Swan
Dave Overhulser
Tom Huffaker

10:30 a.m.

CONCURRENT WORKSHOPS III:

1. CANUSA at midpoint.
Mel McKnight
2. Pest management for urban trees.
Dave Neilson
3. Getting a handle on forest insect dispersal.
Roy Beckwith
4. Local benefit-cost methods for budget constrained IPM. Tom Bible
5. Components of pest management systems for bark beetles.
Les Safranyik

Wednesday, March 4, (Cont'd)

12:00 Noon

LUNCH

1:00 p.m.

Interest Groups, Local Tours

7:00 p.m.

Banquet, Presentations "Canadians
to Climb Mt. Everest".Thursday, March 5

8:00 a.m.

Final Business Meeting

8:30 a.m.

PANEL 3: The Mt. St. Helen's eruptions
and their significant to forest
entomology.Moderator: Boyd WickmanPanelists: Rick Johnsey
Dave Overhulser
Gary Long

10:30 a.m.

CONCURRENT WORKSHOPS IV:

1. Genetic variability of forest insect populations and implications for IPM. Molly Stock
2. When can biological control contribute significantly to pest management? Imre Otvos
3. Computerized integrated management systems - who'll use them? Don Burnell
4. Large scale aerial spraying - will we ever use them again in the west? Jack Barry
5. Can we adequately define the impact of grazers on forest trees? Gary Long

Thursday, March 5, (Cont'd)

12:00 Noon

LUNCH

1:00 p.m.

PANEL 4: Are we making progress?Moderator: Ron Stark

3:00 p.m.

CONCURRENT WORKSHOPS IV:

1. Mountain pine beetle management
with references to constraints
from other resource agencies.
Mark McGregor
2. Seed orchard pest management.
Gordon Miller
3. What new approaches will be
available to the land manager
in the 1980's? Tom Flavell
4. Sparse insect populations.
Jan Volney

ADJOURN

Speakers, Moderators and Panelists - Affiliations

CANADIAN FORESTRY SERVICE

Cayford, Jim; Ottawa, Ont.
Cerezke, Herb; Edmonton, Alta.
Hall, Peter; Victoria, BC
Harris, John; Victoria, BC
Miller, Gordon; Victoria, BC
Otvos, Irme; Victoria, BC
Safranyik, Les; Victoria, BC
Shepherd, Roy; Victoria, BC

OHIO STATE UNIVERSITY

Nielson, Dave; Columbus, OH

OREGON STATE UNIVERSITY

Bible, Tom; Corvallis, OR

PACIFIC LOGGING COMPANY

Devitt, Bruce; Victoria, BC

REVELSTOKE SAWMILLS

Swan, Brodie; Radium, BC

TEXAS A&M UNIVERSITY

Payne, Tom; College Station, TX

UNIVERSITY OF CALIFORNIA

Dahlsten, Don; Berkeley, CA
Volney, Jan; Berkeley, CA
Waters, Bill; Berkeley, CA

UNIVERSITY OF IDAHO

Stock, Molly; Moscow, ID
Stoszek, Karl; Moscow, ID

USDA, FOREST SERVICE

Barry, Jack; Davis, CA
Beckwith, Roy; Corvallis, OR
Buffam, Paul; Portland, OR
Colbert, Jim; Portland, OR
Daterman, Gary; Corvallis, OR
Flavell, Tom; Portland, OR
Huffaker, Tom; Washington, DC
McGregor, Mark; Missoula, MT
McKnight, Mel; Washington, DC
Stark, Ron; Portland, OR
Tunnock, Scott; Missoula, MT
Wickman, Boyd; Corvallis, OR

WASHINGTON STATE DEPT. OF NATURAL RESOURCES
Johnsey, Rick; Olympia, WA

WASHINGTON STATE UNIVERSITY
Berryman, Alan; Pullman, WA
Burnell, Don; Pullman, WA
Long, Gary; Pullman, WA

WEYERHAUSER COMPANY
Overhulser, Dave; Centralia, WA

THIRTYSECOND WESTERN FOREST INSECT WORK CONFERENCE

Minutes of the Executive Committee Meeting

Banff, Alberta, March 2, 1981

Chairperson Buffam called the meeting to order at 8:30 p.m.
Present were:

Paul Buffam, chairperson
Skeeter Werner, secretary-treasurer
Stu Whitney, councilor
Bill Ives, past chairperson
John McLean, programs chairperson
Dick Wong, local managements chairperson
Les Safranyik, past secretary-treasurer
Tony Smith
Mark McGregor
Ken Gibson
John Dale

Absent were councilors Molly Stock and Bill Ciesla. Minutes of the 1980 Executive Committee Meeting and the Treasurer's Report were read. Minutes from the final business meeting of the 1980 WFIWC were read and approved. John McLean reported no changes in the program except that the displays would be in the main meeting room.

It was noted that the term of one councilor, Bill Ciesla, would expire at the conclusion of the 1981 conference. Chairperson Buffam appointed Stu Whitney, Mark McGregor, and Dick Hunt as a nominating committee to nominate new candidates for this position.

The past secretary-treasurer reported that the membership list was updated in 1980 and that all members who had not attended the last three meetings were notified that they would be dropped from membership unless they indicated otherwise. The secretary-treasurer was informed to contact non-registered members every other year in respect to their membership.

There was discussion on establishing a historian position in order that past work conference proceedings be maintained in a safe and orderly manner and that past established by-laws or amendments to the constitution be updated in a more useable form. Dick Washburn rewrote the constitution in 1969 and included all amendments added from 1960 through 1967. Chairperson Buffam will contact Dick Washburn about the historian position.

The 1982 WFIWC will be in Bozeman, MT., with Ken Gibson and Mark McGregor in charge of programs and Scott Tunnock and Hu Meyer in charge of local arrangements.

A motion was made by Les Safranyik and seconded by Dick Wong to reduce student registration from \$15 to \$10 for the Banff meeting and to reimburse those students who have already registered.

The Executive noted that an invitation for the 1983 WFIWC needs to be called for at the 1981 initial business meeting.

Treasurer Werner announced that the WFIWC was now registered with IRS in the United States and the employer identification number is 92-0078709. He also stated that a savings account and now checking account were opened at FedAlaska in Fairbanks. Both accounts accrue interest at seven percent.

The meeting adjourned at 9:45 p.m.

THIRTYSECOND WESTERN FOREST INSECT WORK CONFERENCE

Minutes of the Initial Business Meeting

Banff, Alberta, March 3, 1981

Chairperson Buffam called the meeting to order at 8:30 a.m. at the Banff Center, Banff, Alberta. He welcomed the members to Banff and a special welcome was extended to members of the Southern and Eastern Forest Insect Work Conferences.

Minutes of the 1980 Final Business Meeting and the Treasurer's Report were read and approved. The Treasurer reported a balance of \$184.71 (U.S.) funds and \$897.38 (Canadian) funds at the beginning of the 1981 meeting.

Minutes of the 1981 Executive Committee Meeting were read. The Executive discussed the possibility of asking Dick Washburn to serve as curator/historian for the WFIWC in order to update the by-laws and amendments to the constitution and provide safe storage of the past proceedings and other important documents associated with the proceedings.

A motion was made and passed to authorize Chairperson Buffam to contact Dick Washburn in regards to the curator/historian position and to use conference money for any travel or postage necessary for gathering information.

The common names committee report prepared by T. Torgerson was read by the secretary-treasurer. Chairperson Buffam requested the report be posted in the main meeting room in order for members to familiarize themselves with proposed common names, and a proposal for procedural changes in notifying the membership about proposed common names and the approval of the names.

Proposed common names are western budworm for Choristoneura occidentalis and western conifer seed bug for Leptoglossus occidentalis. The proposed rules change would consist of notifying members of any prepared common names prior to the annual meeting at that time when the program announcement is sent to the members rather than 30 days prior to the meeting.

Chairperson Buffam asked Molly Stock to assume the Ethical Practices Committee Chairpersonship, replacing Dave Holland who couldn't attend the work conference.

Chairperson Buffam appointed Stu Whitney, Mark McGregor, and Dick Hunt to serve as a nominating committee for selecting a new councilor to replace Bill Ciesla.

Scott Tunnock confirmed that the 1982 work conference will be held at Bozeman, Montana and provided a brief description of the transportation facilities and recreational areas.

John Dale invited the 1983 work conference to California. He suggested a combined meeting with the WFDWC but stated time may not allow for adequate planning for a combined work conference.

John Foltz invited members to the 26th Annual SFIWC to be held at Gainesville, Florida, August 11-13, 1981.

Chairperson Buffam asked for a moment of silence in remembrance of four members who passed away during the past year. F. Paul Keen, Robert L. Furniss, and James C. Evenden were members of the first WFIWC, and Julius Rudinsky was a member for many years.

There being no further business the meeting was adjourned at 9:00 a.m.

TREASURER'S REPORT

Western Forest Insect Work Conference

March 3, 1981

Balance on hand March 1, 1980:	\$ 471.95	(CAN)
Income from El Paso, Texas, Conference	(+) \$1879.00	(U.S.)

Expenses of El Paso Conference:

Holiday Inn	(-) \$ 627.60	(U.S.)
Adventure World Travel	(-) \$ 360.00	(U.S.)

Balance on hand, March 10, 1980:

a) Canadian Account	\$ 884.05	(CAN)
b) U.S. Account	\$ 527.50	(U.S.)

Interest income:

a) Canadian Account	(+) \$ 13.33	(CAN)
b) U.S. Account	(+) \$ 13.57	(U.S.)

Expenses:

Printing 120 copies of 1980

Proceedings	(-) \$ 291.02	(U.S.)
Envelope and postage	(-) \$ 66.34	(U.S.)

Balance on hand March 2, 1981: \$184.71 (U.S.) + \$897.38 (CAN)

KEYNOTE ADDRESS: FOREST ENTOMOLOGY CHALLENGES OF THE 80'S

J.H. Cayford

Premier Brian Peckford of Newfoundland said in February, 1981 that he has reluctantly accepted a Royal Commission's recommendation that chemical sprays be used to fight a spruce budworm infestation that could eliminate the province's forest industry within a decade. Peckford said the chemical matacil will be used in 1981 to spray about one million acres of forest at a cost of \$4.5 million. The Royal Commission says there is no evidence any of the available chemicals, such as matacil, fenitrothion or acephate, are dangerous to humans.

In early April 1978, Premier Regan of Nova Scotia firmly rejected a recommendation of a task force on wood allocation and forest management in Nova Scotia. The recommendations called for limited spraying for foliage protection, to be repeated until the budworm epidemic collapsed. The Premier stated "frankly, we're so strongly opposed to the aerial spraying of insecticides that I can't conceive reopening the debate." This decision reinforced a decision made a year earlier when "the Nova Scotia cabinet decreed that because of the possible hazard to public health and to the environment, aerial spraying of chemical insecticides will not be permitted."

The two foregoing statements, represent your most significant challenge of the 1980's. You have some tools for forest pest management but in many instances are unable to use them. Accordingly, you need either new techniques or you need to educate the public in such a manner that you will be able to use existing techniques. I would suggest that you need action in both areas if the forest resource is to be protected from economically important damage as a result of forest insects.

I have been asked to speak to you some challenges facing entomologists in the 1980's. Before I speak to you on my perception of the challenges, I will talk briefly about Canadian forestry. Perhaps this section could be call Forestry 100.

There is no doubt that Canada is one of the leading forested nations in the world. There is only one other country - the Soviet Union - that has a greater forest estate. Here in Canada we have a belt of forest land that varies from 1,000 to 2,000 km wide, and which extends from the Atlantic to the Pacific Ocean.

The forest industry is the leading generator of economic activity in this country. It employs some 300,000 persons directly, and it is estimated that another 600,000 persons are employed indirectly as a result of the industry. These include individuals in a variety of service industries and in government institutions. One out of every 10 Canadian workers owes his or her livelihood to the forest industry.

Most of our forest products are exported and as a result the forest industry contributes more to Canada's net balance of payments than agriculture, mining, fisheries and fuels combined. In 1980, exports of forest products totalled about \$12.5 billion while we imported less than \$1 billion, resulting in a trade surplus of \$11.5 billion. The forests are also very important in providing revenue to both federal and provincial governments. It is estimated that in 1980 these revenues totalled about \$3 billion. In Canada we have about 300 single-industry communities that essentially depend on the forest industry for their total economic support.

In addition to these economic values, Canadian forests also provide environmental and social values. The forests provide a backdrop for a multi billion dollar outdoor recreation industry. They enrich the lives of many Canadians, they moderate climate, clean the air and improve water quality; they check erosion, regulate stream flow, minimize floods and provide the habitat for fish and game. Finally, by the year 2000, the forests may be the source of about 10% of our energy supply.

In view of the economic and social values of our forests, one would rightfully assume that we Canadians would be applying modern techniques of management to ensure that the crop is renewed. Unfortunately, such is not the case. We are treating the resource as if it is non-renewable - we are mining our forests, not managing them.

Each year we are seriously depleting our forest resource. We harvest about 800,000 ha annually, we plant or seed perhaps 125,000 ha and we depend on nature to regenerate another 500,000 ha. We leave from 150,000-200,000 ha unregenerated. In addition we have a backlog of some 25,000,000 ha that we have failed to regenerate following past harvesting and fire.

Until recently there was little concern about the state of our forests. We were quite content to look over the next hill or mountain. However, we now realize that our forest supply is not unexhaustible and indeed if we do not change our philosophy, we will not be able to sustain even our present level of timber harvest. Fortunately, the climate is changing and we are embarking on new forest management strategies that I anticipate will result in improved forest management.

At the federal level the Canadian Forestry Service will be assuming a higher profile. In recognition of a renewed commitment to forestry, the status of the service has been elevated within Environment Canada and is now headed by an Assistant Deputy Minister rather than by a Director General as previously. The mandate of the Service has also been expanded from that of its traditional research and development role. New activities include the coordination of federal forestry activities, the provision of leadership in international forestry, the collection and publication of national and international forestry statistics, and the anticipated development of federal-provincial agreements in forest renewal. To undertake its new responsibilities the CFS-HQ has been reorganized with the establishment of three directorates - Policy and Economics, Forestry Relations and Renewal, and Research and Technical Services. Additionally, I anticipate a minor reorganization within our forest research centres which will involve the establishment of a unit concerned primarily with policy, economics and operational matters.

A Federal Forestry Sector Strategy Committee, chaired by the Assistant Deputy Minister, Canadian Forestry Service, has been established to coordinate the activities of federal agencies that affect the forestry sector. The Committee includes representation from such agencies as Environment; Finance; Employment and Immigration; Transport; Industry, Trade and Commerce; Regional Economic Expansion; the Privy Council Office; Treasury Board; Agriculture; Indian and Northern Affairs; the Ministry of State for Economic Development; Energy, Mines and Resources; the Federal-Provincial Relations Office; and the Natural Sciences and Engineering Research Council.

Establishment of this committee constitutes formal recognition that many different agencies have an impact on the forestry sector. It will ensure that initiatives by federal agencies are coordinated among all of the agencies concerned. The Committee has already initiated a number of studies that we hope will serve as the basis for federal initiatives and discussions with the provinces during the coming year. The studies include:

- * Federal support for research and development;
- * assistance for forestry school graduate training programs;
- * manpower planning in forestry;
- * the impact of transportation constraints on the forest sector;
- * forest industry trade and development initiatives;
- * funding mechanism in support of forest management.

They are scheduled to be completed early in 1981.

Evidence of a new Canadian awareness of the importance of forestry is also found in recent initiatives undertaken by several provincial governments. New forest policy and management initiatives are in progress in British Columbia, Alberta, Manitoba, Ontario, Quebec, New Brunswick, and Newfoundland. We have seen new legislation in several provinces and a trend towards more involvement of the forest industry in forest management. This is a significant departure in view of the fact 80% of our forest land is publically owned by the provinces and most of the industrial activities are carried out under some form of agreement with a provincial government.

There have also been a number of significant national forestry conferences in recent years. In 1977, the Canadian Forestry Association - our counterpart to the American Forestry Association - sponsored a National Forest Regeneration Conference in Quebec. The dismal Canadian effort in forest regeneration was high-lighted at this conference.

In 1979, the Financial Post - one of our leading financial newspapers - sponsored a National Forestry Conference which was held in Vancouver. More recently, just last fall, the Canadian Pulp and Paper Industry sponsored the Canadian Forestry Congress which represented a further effort to review current Canadian efforts in forest management. Once again, the inadequacy of our current programs was forcefully outlined.

Another encouraging sign of an increased awareness of our forests is the attention that the press is now directing to forest management. For example, the August 1979 issue of the Canadian edition of Reader's Digest featured an article on forestry and in the same year one of our major banks, the Royal Bank of Canada, devoted its July issue of its monthly newsletter to forestry. Daily newspapers have recently published editorials and feature articles on forest management.

I have spent perhaps too long on this general background material but nevertheless, I feel that it is important to continually focus on the importance of our Canadian forestry industry. In much of our nation it is the only game in town.

I would now like to spend the remainder of my time discussing the challenges facing entomologists. Most of my comments are directed specifically to the Canadian situation; I simply do not know how relevant they may or may not be to the U.S. situation.

My first challenge is quite simple - forest entomologists must become part of the forest community. For too long, forest entomologists have seemed neither fish nor fowl - you are but a small component within the entomology scene, with most attention paid to agricultural entomology, and you are but a small component within the forestry scene.

I have a few specific points to make that indicate the relatively low profile of forest entomology and forest entomologists in this country.

- (1) At one time, forest entomologists played an important management role within the Canadian Forestry Service. Now, however, only 4 of our 12 senior positions are occupied by entomologists. Not too many years ago, forest entomologists were the dominant force within our forest insect and disease survey. Now the Director of the survey and five of six unit heads are forest pathologists.
- (2) At the Canadian Forest Congress held in September 1980 the paper on insects and diseases was presented by a silviculturist, Dr. Gordon Baskerville. Indeed, Dr. Baskerville is one of the major spokesmen on the spruce budworm.
- (3) At the University of Toronto, Faculty of Forestry, there is no forest entomologist among the permanent staff. At Lakehead, both forest entomology and forest fire are taught by the same staff member.
- (4) In mid-February, I attended a major forest conference in New Brunswick sponsored by 3 forestry associations, the Canadian Institute of Forestry, the New Brunswick Forest Products Association and the New Brunswick Association of Registered Professional Foresters. About 150 foresters were in attendance - but I saw only 5 entomologists. Of these, one is retired, two are no longer in entomology, while the other two are nearing retirement. Yet, the most important forestry problem in New Brunswick is the spruce budworm.
- (5) The Canadian Institute of Forestry is the major national forestry organization in Canada. It is roughly comparable to the Society of American Foresters. Yet membership by our forest entomologists is very low. Within the Forest Pest Management Institute, a major National Institute, only 2 of 26 professionals are members. Of the 4 entomologists who are CFS Directors, 2 are not members of the C.I.F. and most of our research scientists in entomology do not belong to the organization.

In contrast to forest entomologists, I believe that forest pathologists are well integrated into the forestry community. The difference may well be that the majority of our pathologists have a forestry degree, while the majority of our entomologists have a science degree. What we seem to need is a renewed awakening of entomology within our forestry schools where entomology is at a low ebb.

The time is now appropriate for you to move out of your forest entomology mold and to stand up and be counted amongst foresters. It is widely accepted that forest protection is an integral part of forest management. Indeed without protection, there is little rationale for management. And with an increase in man-made forests, and in intensive forestry, we are bound to encounter more and more forest pest problems. Specific examples here are the black army cutworm outbreaks in British Columbia in stands planted immediately after slash burning and the rapidly escalating importance of seed and cone insects attacking seed orchards.

My second challenge relates to the need for new biological techniques for forest pest management, and the need to refine our knowledge on those most promising techniques. The Baskerville Task Force Report of 1976 concluded that there was no real alternative to chemical spraying. However, one biological insecticide, Bacillus thuringiensis (B.t.) was considered operational. Baskerville went on to say:

"use of B.t. may be indicated where some protection is desirable and the use of chemicals is precluded for environmental or social reasons, but it is not, at present, considered an adequate substitute for chemical insecticides in large-scale crop protection."

From my perspective, the situation described in November 1976 has not really changed, some 4½ years later. Accordingly, I would challenge you to take stock of the current situation; assess what we know with respect to B.t., determine what we should know and develop programs to fill the knowledge gap. This topic must be pursued with vigor as forest managers are anxious to add B.t. to their arsenal of techniques in the fight against spruce budworm. There is also a need to pursue with vigor the use of pheromones. While several trials have been carried out, there seems to me to have been no overall strategy of pheromone research in Canada. You should also not ignore the opportunities that may be afforded through mass production and liberation of parasites and predators and through development of integrated pest management strategies that will involve the use of forest management practices as well as direct control methods.

Challenge number three deals with the need to obtain more information on the human health aspects of forest protection programs. Concern for human health first became evident when it was postulated that a rare children's disease, Reye's Syndrome, was thought to be linked with spruce budworm spraying. Although this particular hypothesis has not been verified, the concern for human health continues to this day, and is a major factor to be considered insofar as the future use of chemical spraying as a forest management tool. Research on human health effects is beyond the scope of conventional forest entomological research programs and accordingly in the CANUSA spruce budworms research program has been given little consideration. There is a need for forest entomologists to play a leading role in promoting and inspiring medical research on the effects of forest insecticide spraying. Research might be first directed to those workers who are intimately associated with the spray programs. Both the CANUSA Program Managers and the Eastern Canada Spruce Budworm Council are currently trying to develop a more collaborative approach with government health authorities.

My fourth challenge to you is to learn more about the technology of large-scale aerial spraying - basically to develop improved strategies for chemical insecticide application.

Research in the pest management field is continually being directed towards alternatives to chemical control. There is, however, a serious concern among resource managers, that in our quest for biological control products, emphasis on improving those tools that we already have is lagging. As many land managers see it, the options that they already have are in peril. There is a major link between the human health issues that face aerial control operators and the efficiency of existing delivery mechanisms. It is well documented that with our present spray technology, only a proportion of the emitted volumes reach the target protection area, and an even smaller proportion impacts in the range of the pest insect. It follows that the remainder, known as off-target drift, adds an unnecessary pollution level to the surrounding area. It is to this off-target aerosol of insecticide that the greatest human health risk criticisms are directed. The challenge, and one that many feel we must respond to rapidly or lose the chemical option entirely, is to refine the delivery system and formulations in such a manner as to direct all, or the vast majority of the spray emissions to impact on the target areas. This would entail a revamping of the aircraft hardware, a better understanding of spray droplet behaviour, and the optimum formulation characteristics to achieve the desired results. It has been noted that despite the enormous sums being spent annually against the eastern budworm in chemical spray programs, spray application and drift have so far received scant attention in CANUSA programs. Fortunately, I feel we are making some progress here with recently announced programs by the New Brunswick Research and Productivity Council and by the Canadian Forestry Service.

The fifth challenge is to develop multi-disciplinary research teams to address forest insect problems. Thus, the spruce budworm should be considered in the context of a forest management problem rather than as an entomological problem. A review of CFS research projects indicates that by and large the entomological program is structured on a discipline basis. For example at the Great Lakes Forest Research Centre, there are projects dealing with both spruce budworm and with the management of spruce-fir forests. Multi-disciplinary research teams might well include specialists in such disciplines as forest entomology, forest pathology, silviculture, ecology, soils, and tree physiology and would focus on forest management problems of a given forest tree species or cover type.

Challenge six is the need to develop improved damage appraisal systems in order that losses from forest pests may be quantified and that loss statistics can be integrated with provincial inventory statistics to provide regional and national estimates of losses from insects and diseases. The forest insect and disease survey of the C.F.S. is making an encouraging start in this direction but there is still a tendency for the survey to focus on insects and diseases, rather than on trees and forests. We also need better information on the prediction of losses over a 5- to 10-year time frame and we need more detailed information that will enable us to predict the future development of individual trees after insect or disease attack.

Challenge seven is the need to apply information already known. This is a challenge not only for entomologists, but also for forest managers; failure to utilize available information is a reflection on both the researcher and the user alike. I believe we already have a lot of information available that is not being used. The challenge is for the research agencies to place increased emphasis on technology transfer, while management agencies must develop the entomological expertise needed to put research into practice.

Challenge eight is of particular concern to the C.F.S., but probably also to other major employers of entomologists. Basically, the age distribution of entomologists is skewed towards the older age classes. In view of the low level of current entomological graduate training in Canada, and particularly in forest entomology, it will be difficult to replace our older, experienced entomologists. In the 1980's many entomologists will be leaving CFS, and their years of experience will be lost. Before these specialists retire, we should undertake a concerted effort to avoid the irreplaceable loss of the experience of a generation of entomologists. It is possible that the knowledge and experience of these scientists could be captured in computer simulations, which offer a convenient and useful "archiving" medium.

The ninth and final challenge is the need to increase our efforts on the development of preventive techniques of pest management as alternatives to control techniques. This will require that the CFS and other agencies rejuvenate the capability in insect population dynamics that has been seriously eroded in recent years.

In these remarks, I have tried to outline some of the challenges that I believe will be facing forest entomologists in the 1980's. During the next decade Canadian forestry will come of age. Our forest resources are barely sufficient to meet existing demands and intensive forest management will become the rule rather than the exception. Forest entomologists will be expected to play a more important role than in the past and I am confident that you can meet these challenges.

PANEL 1: WHAT ARE SOME OF THE RESEARCH CHALLENGES AHEAD?

Moderator: Donald L. Dahlsten

Panelists: Bruce Devitt, Roy Shepherd, Tom Payne, Mel McKnight

It was hoped that this panel could get the Work Conference off to a good start. The research challenges in the 80's are upon us already. There is a need for fiber, and forest practices are changing rapidly to meet these needs. For the researcher, this means new insect problems to go along with many of the other problems that we haven't solved yet. Now that Integrated Pest Management (IPM) is becoming fashionable, the forest entomologist finds that she/he must work with pathologists and other forest specialists and particularly with the forest managers. Implementation of IPM programs involves considerable research as well as communication. However, the funds for conducting research and training new scientists are rapidly dwindling away. We can identify the problems but will we be able to study them, will we be able to train new scientists, and will there be any jobs for the young researchers we have trained?

We are fortunate to have four experienced individuals to address the issue of the research challenges ahead. Our speakers come from diverse organizations and backgrounds and they will appear in the order as listed on your program.

Establishing and Tending the Crop - Bruce Devitt

At a recent annual meeting of the Canadian Institute of Forestry (Ottawa 1980) 21 of the section directors attending were asked the question "What constraints (or challenges) to forest renewal and tending do you face for the area covered by your section?" The answers of course varied but there was a common theme:

1. Protect the land base
2. Protect the crop (fire, diseases, insects, competition)
3. Get small forest land owners interested in forestry
4. Shortage of dollars, trained people, and research
5. Lack of legislation

Therefore the topic you have chosen for you conference is very timely. Protecting the crop and the dollars invested in it ranks high on the list. We must all address these problems and apply our training toward solving the issues involved. Without doubt the major public concern is over the use of pesticides and herbicides. We could lose these needed tools. So our first challenge is to meet these concerns. The public and politicians are demanding the best of advice and recommendations for action. So far we haven't done a very good job. Mostly because we speak in a language little understood and as a consequence our research funding has been sadly neglected.

In addition our recommendations in the past have not been put to strongly weighing the costs and benefits. We need to assess, weigh, decide, recommend, monitor, and change. In short we need to use our training and experience and take action based upon it. A further constraint is that we do not use enough of these chemicals to get the support for the research needed so that they can be registered and used in a safe manner. We really need to press for action in this area.

The second challenge is fairly obvious. We all know insects are constantly at work threatening present and future timber supplies or other desired forest uses. They are at work at every stage in a forests development from seed to maturity. Yet we have not yet been able to appraise, quantify, and monitor to provide information needed for management. We usually are in a crisis, fire fighting mode. We must devise better monitoring methodology using computers to integrate the weather, crop nutrition, soil moisture, and insect biology to predict pest warnings, to provide better estimates of growth, drain and costs, and to provide for the management decisions and control procedures needed.

I am really a strong supporter of having good monitoring procedures. At Pacific Forest Products we are currently putting into place a land and forest stratification system so that we can better monitor tree growth at each stage of crop tending. This system based upon the interaction of land, environment, and forest will also be used to assess for disease, insects, and nutrition difficulties. But so far we lack the monitoring technology. It is a complex business, it needs to be resolved so that we can devise cost benefit management strategies.

Monitoring is also needed at the forest nursery and seed orchard levels. It's been my experience that most problems that have developed and got out of hand did so because the people involved were not aware they had a problem until it was too late.

A third challenge is to broaden our species tool kit. We have had a "head-in-the-sand" rather than a "how can we manage to work around this problem" approach. Currently we do not plant Western White pine because of the blister rust. Yet others do. Our abies species have been neglected because of the balsam woolly aphid. Sitka spruce has the terminal weevil. Lodgepole pine has problems with the pine shoot moth. Douglas-fir has a major root rot problem. Soon there won't be a species without a major problem. We must research and devise methods for using our species to the full. We should avoid total mono cultures and provide the diversity needed. Having a broad versatile species tool kit is important.

A fourth challenge is to put what we know into practice. Execution in a safe, proper and efficient manner will insure success. An interface is needed between researchers and the managers. Useful techniques include "team" research, specialists doing pilot trial tests, workshops, computer listings of whats been done by whom, and good cooperation and communication.

Most of what I have said here is not new. The past twenty-five years has seen much change in a number of fields but unfortunately it has been a struggle in your area of research to get done what was done. We are now paying for this neglect. It is making forest renewal and crop tending difficult. Our knowledge is not adequate for efficient execution. However, the winds of changes are blowing and during the 80's we must get our act together and work to make a better public understanding of the needs, make decisive recommendations, execute our jobs well and monitor more in order to manage better.

Research Challenges in Forest Defoliator Research - Roy Shepherd

Research challenges - have they changed in the last ten years - I think not. The challenges that face us today are the same as those that faced us in the seventies. We can define them better, we can ask better questions, but the problems remain. If anything, these problems have been intensified by the greater demand by people for access to the forest for an ever-widening scope of uses. But fortunately, this greater use of the forests is accompanied by a greater appreciation of the role that pests play in the dynamics of the forest community.

Research in the 70's became more applied, more short term, and as a result, provided short term solutions. It relied upon the basic knowledge collected in the 50's & 60's. That basic knowledge provided a degree of understanding never before attained. A great surge of studies on population dynamics and life tables enabled us, for the first time, to appreciate the complexity and interactions involved. Research in the 70's was nourished on that knowledge, parasitised, if you like, on the knowledge gained at that earlier time. Most of the ideas that evolved out of that knowledge have been gleaned out; we are, so to speak, intellectually bankrupt. New ideas and concepts are not being taken up and explored as they should be because management is not supporting basic research at an adequate level. We are just turning the same old wheels faster and faster.

Progress in applied research is highly dependent upon a thorough understanding of the dynamics and interactions of the insect and its ecosystem. Without it we end up modifying one factor and causing two more problems down the road.

Many other areas of science developed rapidly in the 70's and entomologists are madly trying to take advantage of this and solve our problems with their ideas and techniques. One of these is the computer-based modelling of population ecology and its interactions with the forest. Although valuable in many areas, its greatest value has been, perhaps, pointing out our lack of understanding of the ecosystems involved. This brings us to the first and main challenge facing forest entomologists - the return to studying basic concepts to develop an adequate understanding of the interrelationships between insects and the other biotic and abiotic factors in their environment. This does not mean going back to life tables, based upon massive sampling of the insect, but detailed quantitative studies of the interrelationships. We can let the computer boys put the systems together, but, their results are meaningless unless they are based on sound quantitative data. It will require studies which are at least a X 10 degree more complex and difficult than those presently undertaken.

For instance, we have attempted to correlate population trends with weather patterns, often with poor success, because we don't understand the causal relationships. Even if we get a positive correlation, it may not be useful for predictive purposes because we don't understand why changes are occurring. Such correlations are also based on the broad assumption that certain weather types are good or bad for a generation of insects as a whole. We know that such an assumption is not really true, but we're forced to make that assumption because we couldn't handle a greater degree of complexity. Now we realize that we must look at weather influences for each small stage of the life cycle. Cool, wet weather will be advantageous for certain stages and disadvantageous for other stages. A population trend will be a sum of the parts and correlations will be multiple, interdependent and horribly complex. But it must be done. Forest entomology, as a science, must, again, develop a sound scientific basis before significant progress can be made at the applied level.

To become more specific and discuss defoliator problems, to which I am supposed to speak, I think the greatest progress we have made, in recent years, is the development of the concept of a total pest management system. For the first time we can see the total framework necessary to manage defoliators. We can see what information, techniques and control systems are necessary to do the job. We don't have all these in place, even for one insect, but at least we know where we are going. We can probably thank the scientists who worked on the Douglas-fir tussock moth for the development of this concept, and we are probably closer to the realization of our goals with this pest than with most others.

A good pest management system really depends on the old four W's: what, when, where, and why, except we put them in a slightly different order.

Characteristically we have had big swings in our population cycles. Populations go through density ranges of at least $\times 100,000$ and have rapid rises and falls. Some insects are fairly regular in their cycling, some are so irregular that they can't be called cycles at all. Previously we were unable to monitor the population densities at the endemic levels so that outbreaks arrived unannounced. The first year of defoliation gave us a clue that an outbreak was underway. We scrambled around the next year, undertook a bunch of surveys, wrote assessments, environmental impact statements, budget requests, etc., and in the third year managed to apply a control just as the population was collapsing. Basic research on the impact of defoliation is now telling us that damage during the first year of defoliation is, perhaps, the most important and if we want to control a population it should be done before that time. i.e. We have to have a way of tracking populations at all population densities through the endemic levels and predicting outbreaks before they happen. Fortunately pheromones can do this job for us. That is the first W in the management system - when will population densities likely arrive at outbreak levels.

At the same time that we are learning to understand and measure changes over time we must also understand and be able to measure spacial changes. The ecological associations between outbreak patterns and habitats must be known. Maps of topography, climate, forest types and plant communities are all invaluable tools to be able to determine where outbreaks are likely to occur. Each species is quite different in this regard. Some have very specific requirements and will rise to outbreak levels in small restricted habitats. Other pests have broad requirements and seem to be able to rise to outbreak levels anywhere the host is present. Associated with this of course is the need for an understanding of the dispersal characteristics of each species - a notable challenge in itself. If we can define an area of possible outbreak, then monitoring for population trends over time can be simpler by confining the monitoring to that area. Again, as you are approaching a pre-outbreak period, extensive pheromone trapping will help define locations of high densities. This gives us the second W - where will outbreaks occur.

Once you have systems in place that tell you current population levels and where outbreaks are likely to occur you are faced with predicting at least a year ahead. To do this you must understand the dynamics of the insect and why densities fluctuate. If you know the causes of the cycling, whether it be weather, parasites or virus, then, and only then, can you predict with confidence the population levels and locations next year. It will not be sufficient to rely wholly on things like a correlation with July maximum temperatures or the rate of overwintering egg parasitism unless you understand how they affect the pest. So we need much more basic information on why populations fluctuate - the third W.

As soon as you make your predictions the forest managers, of course, will ask you the fourth W - what does it mean for the forest and what can I do about it. When we look at impact, the forest managers are often shocked by how little we know. Very little work has been done in relating defoliator feeding to growth losses. This is partly because we don't even have a sound theoretical base on which to operate. As an illustration, we have been studying this problem at PFRC for over ten years and are only now beginning to realize the nature of the damage, let alone trying to quantify it. This is an area that screams loud and clear for basic physiological-mensurational studies on tree growth.

The "what-can-we-do-about-it" questions are also not easy ones to answer. In the 50's and 60's the answer seemed to be more and better chemicals, but now we realize that this is, perhaps, not the best response. In the 80's control research will probably steer away from this field and head into other areas. Biological controls with parasites, predators and microbials present obvious alternatives which should be looked at, but I would like to emphasize another one, which from my view point, is more promising because, instead of looking for more ways of controlling defoliator outbreaks, I believe we should be trying to prevent outbreaks. This, of course, throws us right back to my first appeal for more basic scientific research on the causes for population change and how they can be modified to minimize fluctuations. It brings us back to square one, when you were a student, and the forest entomology professor

said that the best way to control pests is through forest management. That was a great motherhood statement, but I often wondered why nobody was working on it; does it have a place in the real world. There were reasons for ignoring this concept. The level of forest management ten years ago didn't allow for spacing, partial cuts, species selection, brush control, breeding, or selection of super trees. Ten years from now they will be standard practice and the foresters will be screaming in your ear for guidelines on how to grow a bug-proof forest. Besides species selection at cutting or planting, we have to think of trees which can withstand defoliation by secondary bud production, phenological races with a bud phenology not in synchrony with the host, trees with terpenes or other materials that are distasteful or lethal to insects, trees which react to defoliation by producing descriptive hormones, etc. You may playdown these speculations, but I ask you, have you ever seen a uniformly defoliated forest. Not likely. There is a great range in the degree of defoliation between trees. Why do some trees have little defoliation while their neighbors suffer badly. There are good biological explanations. When you find out why, then a whole new era of research will open up.

Perhaps I have dwelled too long on the research challenges facing scientists, but I must make one more point. Research is the product of two teams: the managers who supply the overall direction and the money to do the job, and the scientists who applied their knowledge and skills to do the work. The weak link in this team is the money supply. By far the greatest challenge of the 80's is for managers to find sufficient dollars to do the job. In the long run, the success or failure of a manager is judged, not on his ability to re-organize us, again, instigate effective communication, or complete zero-based program review's, but on their ability to generate bucks. The greatest challenge lies with them and so I would like to end this talk by throwing them the torch and expressing a sincere wish that they can keep it burning.

Bark Beetles - the challenges ahead - Tom Payne

The challenge for the '80's in bark beetle research lies in the development of integrated forest pest management systems which are operational at the user level by the user. In essence this is practical problem solving, but it does not mean we abandon basic research. Quite to the contrary! Basic research is necessary to provide the building blocks of any sound IPM system. Pest control programs not founded on sound basic research are destined to fail in the end.

Our challenge is not to develop IPM systems as independent entities, but as functional parts of total forest management. This does not mean we researchers must develop total forest management systems. It means we must consider the requisites of forest management in the development of the IPM system to provide for the greatest compatibility with forest management needs and objectives. IPM is now a well-worn buzz word, the use of which far exceeds the number of successful examples, regardless of which ecosystem one considers. Nonetheless, the concept is sound and must be kept as the focal point of research efforts in pest problem solving.

The components of an IPM system have been proposed by many, but the general system set forth by Dave Wood, Bill Waters, Bill Bedard, Ron Stark and others of our colleagues captures the general essence of a system and the areas for research. That is, any IPM system must deal with the areas of impact, stand dynamics, population dynamics and treatment strategies, all of which must be viewed in the light of a benefit cost analysis and integrated into overall forest management. Research on bark beetles clearly has dealt with various aspects of what is needed to build an IPM system; however, until the early '70's most research was fragmented in the light of current ideals. There were some coordinated, concentrated efforts on various aspects of certain bark beetle species, such as the western pine beetle, mountain pine beetle, southern pine beetle and a few others. But, not until the Huffaker project was founded in early 1970, did we begin a large-scale, multi-disciplinary, multi-institutional effort in IPM on bark beetles. Subsequent to the Huffaker project the southern pine beetle became the first bark beetle on which an IPM approach was put forth with both substantial philosophical and monetary backing. The Expanded Southern Pine Beetle Research and Applications Program (ESPBRAP) terminated last September 30 and has served as a format for the development of the Integrated Pest Management Program on Southern Pine Bark Beetles which is currently underway. The Southern Pine Beetle Program, although possibly not an ideal, does provide a model for what and what not to do and how and how not to do it.

What research is needed? An important question which must be answered by the researcher. This does not mean we ignore or omit consideration of the user. Emphatically, it does not! We must develop and maintain effective interaction with the user community to arrive at a mutual understanding of their IPM needs. This is where their "expertise" lies and where they can contribute greatly to the development of IPM systems. The user should not be put in a position of deciding what research should be done or what proposed research should be funded. In general, the user does not have the expertise to adequately carry out that responsibility.

Regardless of the specific pest, efforts to develop an IPM system must include research as outlined below:

IMPACT

Methods must be developed for measuring and predicting biological, socio-economic and environmental impacts of the pest on the forest. To be effective and lasting the methods must be based on an integration of information of pest population, stand dynamics and treatment strategies and be responsive to changing forest values and management needs. Impact models should be developed.

PEST POPULATION DYNAMICS

Methods must be developed for measuring beetle population density. Factors which regulate beetle populations must be identified, their roles determined, and their impact on beetle populations quantified. Models should be developed for predicting beetle population trends based on the above.

HOST DYNAMICS

One of the most critical basic core areas of research in which sufficient information is lacking deals with host susceptibility and suitability. Methods must be developed for measuring and predicting host susceptibility and suitability and followed by the development of predictive models. This area of research holds the key(s) to determine how the beetle becomes a pest, yet to my knowledge an adequate understanding of this critical area has not been obtained for any bark beetle species, including the southern pine beetle. An understanding of host susceptibility and suitability is essential to an overall basic core of information for the development of an effective IPM system.

TREATMENT

Available and potential treatment tactics and strategies must be evaluated for their effectiveness in suppressing and preventing beetle-caused losses. Such things as forest management practices, toxicants, biorational pesticides and biological agents should be considered for their efficiency in suppressing or preventing beetle-caused damage under different forest conditions.

MONITORING

Reliable techniques must be developed for monitoring pest population and forest stand conditions. These techniques must have wide-area application and be remote in nature to be operationally effective in a practical sense. Such monitoring techniques play a key and vital role in the operation and maintenance of any IPM system.

IPM DECISION SUPPORT SYSTEM

The ultimate goal of the outlined research is the development of an interactive system to provide users with sound information on which to base forest management decisions relating to pests. The system will consist of a series of integrated component models developed out of the research in the various areas outlined and must be constructed from a basis of understanding of both the beetle/host system and user needs.

TECHNOLOGY TRANSFER AND IMPLEMENTATION

The value of the system, in the final analysis, will be measured in terms of its suitability, acceptability and use. In this regard, a technology transfer and implementation plan should be initiated at the onset of research on the IPM system and maintained throughout and beyond the research effort. Through such activities user input is maintained in a positive vein. Failure to do so is likely to result in a costly error in terms of time as well as in philosophical support from the users.

IPM systems for the '80's - a noble goal, but how do we reach it? The most efficient route would be through a substantially funded and centrally managed office (e.g. ESPBRAP). The potential for success will be much greater if all researchers of the system are funded, coordinated and held accountable by the same management component. Anything less than this will likely bring increased problems. However, it is highly unlikely that very many bark beetles or forest insects in general will reach such prominence as to loosen the locks on the coffers. Consequently, other avenues must be considered in order to develop needed IPM systems. For example, regional research projects can be organized among organizations and institutions currently concerned with a given pest problem. New funds allocated to specific units, as well as existing base funds and researchers, could be coordinated to work on development of the system. A coordination component could be appointed (elected) to oversee the efforts. The lack of a single source of funds and direction, however, would require added commitment on the part of the researchers and their respective administrators in order to maintain the essential interaction and coordination at the research level.

Regardless of what the support mechanism may be, the general scheme presented for IPM systems provides a means to guide research, maintain needed interactions and bring research results to fruition and use as quickly as possible.

A U.S. Federal Perspective - Mel McKnight

The presentations up to this point have tried to focus on research challenges within specific groups of pest species, both from a research point of view as well as a user's point of view. This, of course, translates into the fact that there are many questions waiting for research to provide answers for. After making that point, I'm going to drop it for the time being and pick it up again in a few minutes.

Not being a licensed soothsayer on Delphinian Oracle, I have restricted my comments to the period between now and, let's say, 1985. If I were to be asked to describe in one word what the next 4-5 years will be like for forest insect research in the Forest Service, I would have to say "challenging"!

During the last 2 years, forest insect and disease research in the Forest Service experienced reduced budgets, limitations on ceilings and reductions in travel. It is quite likely that these constraints will continue, but rather than dwell on them, we must be positive in our thinking and planning to achieve our various program goals and objectives.

In regard to planning, I cannot emphasize enough the need for each of us to become intimately familiar with RPA planning and RPA goals. To illustrate my point, let's look at research priorities and how they are established. Before we do this, however, recall that when I started this presentation I emphasized the fact that there are many questions waiting for research to provide answers for?

Our capacity to ask technical questions about forest insect problems greatly exceeds our ability to answer them. Even if research budgets were doubled, there would still be more questions than answers. Because of this, those who are responsible for publicly supported research programs must analyze and set priorities for forestry research subject to whatever funds and scientific talent are available.

One model used by the Forest Service to set priorities is shown in Figure 1. Here the legislative and administrative requirements of the Executive Branch of Government, plus the opportunities defined by scientists and technical staffs, are important ingredients for priority setting. It is equally important that the various consumers of forestry research also have an opportunity to be heard. And, of course, priorities are influenced by the availability of funds, facilities, talent, and in some cases, the ever changing sensitivities of the political situation in Congress.

In the final analysis, however, research priorities are set by those who have responsibilities for administering research programs--in the case of the forestry schools, it's the Deans and the Department Heads; in the case of the Forest Service, it's the Chief, the Deputy Chief for Research, and the Station Directors.

It is essential that research scientists realize that although administrators may be setting priorities, there is ample opportunity for them and user groups to enter the decision making process (Fig. 1). In fact, only a failure to recognize and take advantage of your vital role in this process could prevent you from interacting with it!

We must all be cognizant of the fact that research priorities are not static and, therefore, we must be alert to new opportunities for research or "emerging issues" as they are often referred to. Being alert, however, is not enough. We must make every effort to relate these emerging issues to projected RPA planning such as the RPA plan for 1985 or 1990. Failure to plan or conceptualize what research needs will be at some future point in time could seriously effect what you may be able to do when that future arrives!

Granted, your original plans may have called for 3 additional SY's and \$400,000 additional funds but all you received was 2 SY's and \$200,000. This is certainly disappointing and it will require a modification of planned objectives to bring them into line with the reduced funding. But, and it is important to keep this point in mind, the look-ahead planning did provide new resources to meet planned objectives.

THE CURRENT FIDR SITUATION

For the next few minutes, I would like to share some observations with you regarding current FIDR personnel and programs. Let's consider personnel first:

There are approximately 105 scientists in forest insect research and:

- * They average a little over 47 years of age.
- * Their average grade is a little above GS-13.
- * They haven't changed locations in the last 5 years.

These seem to be innocuous statistics but under close scrutiny we see that many of our scientists are senior scientists close to retirement. On the other hand, we have few new, young scientists entering the service and, consequently, as retirements continue, the process of passing on accumulated biological information from old to young is broken. Of equal importance is the fact that failure to recruit new scientists greatly reduces opportunities for incorporating new ideas and techniques. Grade level is not of great significance except that an accumulation of high-graded scientists in a given unit can greatly reduce funds available for operating expenses. Lack of mobility in mid-career scientists is most often related to undesirable school disruption; in senior scientists, moves often threaten financial security. Relocation, however, can often revitalize a scientist and provide a stimulating research assignment. In the past, some research programs have suffered for lack of appropriate personnel due to losses for one reason or another. Failure on the part of management to recruit or reassign scientists to fill critical vacancies has reduced the effectiveness of many units and planned accomplishments have suffered accordingly.

Now, let's examine the research work units, themselves. First of all, they have been, and no doubt will continue to be, the backbone of research. They provide the foundation for both planning and reporting. They also have been diminishing in size and capabilities and probably will continue to do so for reasons already touched upon. They will probably shift towards a multifunctional approach as critical mass diminishes or they will become more involved in cooperative research with universities and others to offset reduced staffs. Or, they will be terminated. As they enter agreements with non-FS organizations they will have to negotiate with cooperators on who can best accomplish long-term research. It's quite possible they may have to take on more and more applied research or they may have to actively seek outside funding to support basic research.

The latter point provides good transition to discuss RD&A programs. R&D programs will continue to be essential to the FS as long as they are the principle means of demonstrating the IPM concept and can maintain a high level of research accomplishment. It's quite possible, however, that the R component will diminish over time. R&D programs will continue to compete for a unit scientist's time, usually at the expense of the unit mission. They will continue to direct scientists into an applied research mode and further reduce the unit's overall capability to do long-term basic research.

SUMMARY

These, then, are a handful of my observations and intuitions on where we are and where we are going - at least through the mid-80's. I don't care to speculate beyond that, except to say that a positive attitude and a strong commitment to consolidate and strengthen our research base through better planning will provide a springboard for future expansion when the economic situation improves and new resources are available.

PANEL 2: WHAT ARE THE LAND MANAGER'S NEEDS?

Moderator: Paul Buffam

Panelists: Peter Hall, John Laut, Dave Overhulser

Peter Hall

British Columbia has the second largest productive forest land base in Canada, Ontario having the largest. However, the value of forest products produced in B.C. is over half of the value of forest products produced in all of Canada. The Forest land base in B.C. amounts to 52.1 million hectares of which about 97% is managed by the provincial government through the Ministry of Forests. This area supports a total wood volume of 8.1 billion cubic metres, 94% of which is softwood volume. The volume of wood scaled in 1979, which approximates the amount harvested, was about 76.2 million cubic meters while the value of forest products shipped was almost 7.2 billion dollars.

From the above statistics, it is obvious that the forest resource of British Columbia is large. It is also varied in both age class distribution and species composition, although there is currently a preponderance of over mature stands. Such a large, complex system is subject to losses caused by insect and disease pests. It has been estimated that the average total annual pest caused losses approach 16 million cubic meters and this figure would increase greatly during periods of bark beetle and other pest epidemics. Together, bark beetles and defoliators normally account for almost 10% of this figure. These losses are extremely alarming, especially in light of the predicted "fall-down" in volume when the old-growth stands have been harvested and the lower volume, 2nd growth stands come into production.

In the past year the B.C. Ministry of Forests has established a pest management section within the Protection Branch. Based in Victoria are a manager for pest management, a staff specialist forester and a forest entomologist. Further staffing action will see a forest pathologist and a control-agents specialist, also in Victoria. As well, each of the six forest regions in the province now has a permanent, full-time pest management co-ordinator. This pest management group has a mandate to implement strategies and tactics designed to reduce the impact of pests on the forest resource by 10%.

There will be two main areas of concern for the practicing entomologist. The first area will be along the lines of the traditional role of the entomologist, that is, the entomologist will be asked for solutions for existing acute pest problems and decisions will have to be made quickly. Detection will have to be improved and answers to the question of what and where should be accurate. Pheromone detection traps should be employed where possible as they are specific and are not labour-intensive. Once a potential problem has been located and identified, it must be assessed. The actual area and resource being affected must be determined

and predictions must be made as to the potential duration of the infestation and the potential losses. Based on this information, a decision as to whether treatment is required can/and must be made. If treatment is deemed necessary the entomologist should plan the tactics, i.e. - where, when and with what. All of this must be done keeping cost/benefit in mind, for both the short and long term. Finally, an assessment of the efficacy and impact of the treatment must be made - an evaluation of the success or failure of the operation is necessary for future plans. Pest management systems including detection, assessment, treatment alternatives and evaluation must be put in place and integrated with the other aspects of forest management. Ad hoc treatments and panic reactions to situations are wasteful of time and other valuable and often scarce resources.

The second area of concern for the entomologist is probably more difficult but also may be more important. The entomologist must be able to predict what problems will occur in second growth stands as a result of silvicultural practices. Such insects as Ips and turpentine beetle may become more important than the bark beetles now causing us the most grief and we shall have to supply modifications to silviculture treatments so that insect-caused losses are avoided or minimized. Pest managers and silviculturalists will have to work closely with the net result that pest management will become one facet of forest management. It will be the entomologists job to anticipate and deal with new problems arising from the practice of forest management.

Pest management must become integrated with forest management. Resource managers will be unwilling to accept the losses from insect epidemics and these losses must be avoided. The aim of pest management in the coming years of intensive forest management is to establish management systems which avoid catastrophes.

John Laut

In recent years and even this week Integrated Pest Management (IPM) has become a buzz-word. I must plead, as have other sages before me, that we adopt Integrated Forest Management (IFM) as our credo.

Let me quote, or at least reiterate, some thoughts of earlier speakers: "Entomologists must be better integrated into the forest (management) community" - Jim Cayford. Bruce Devitt pointed out that "land manager must have a game plan" and that we (pest management advisors and researchers) should get involved in that planning. Tom Payne followed by pointing out that IPM systems must operate at the user level by the user. Not as independent operations but as a part of management. We are not pest managers! We must strive to be pest management advisors.

What do land managers need? They need help integrating entomological and pathological information into their forest management game plan (IFM). we specialists must understand that game plan and be willing to play. Too many of us want to referee the game instead of being a player. There already are too many referees - bureaucrats, politicians, public, environmentalists, etc. - with enough whistles and little understanding of the objectives and rules of the game. We should know those rules, accept the game plan and help obtain the objectives. We must not referee!

So what do they need from us? In simple terms, they need to know:

1. What is chewing on his trees?
2. What will it do to his crop?
3. What might be done about it?

Note the intentional emphasis on trees and crops. There are some key differences.

Biologists can answer the first question. We have a long history here. The literature is fat with catalogs, indices, lists and descriptions. We do a good job and should continue.

Before any one can help with question #3, land managers must set objectives (make their game plan). Without an expression of expectations and objectives trees, stands, forests are only trees, stands or forests. Organisms of question #1 are not pests until or unless they interfere with human expectations.

We can and should participate but setting objectives is the responsibility of land managers. Objectives may be lumber, water to drink, cover for game, pulp or paper, trails on which to walk, jog, motor or ski, cover for small birds and on and on. All are valid and once they are set, regardless of time span, those trees, stands, forests and watersheds are crops.

Now that we have some objectives we can return to the question: What will these "pests" do to the crop? This is the test of the pest management advisor. The question is what will happen, not may, or could but will, if nothing is done. How good is our predictive ability? I believe not too good in most instances. Nevertheless the land manager needs our best effort. Our predictions, honestly stated, will be used and we must not back off from making it. Remember the turtle - unless he sticks his neck out he makes no progress.

A pest management advisor is a middle man. A large part of his role is as translator between two worlds - research and application. To be an effective translator requires full fluency in both languages. A key to credibility is mutual understanding.

Question 3 is where most of the credibility is developed and tested. Alternative solutions, mitigating actions along with "best guess" outcomes must be presented. We must not presume to make decisions for managers. They need our best information presented in terms and language they can understand and/or relate to.

To summarize, land managers need:

- speciality players who know the rules, and particularly, the objectives of the manager's game - his game plan.
- pest management advice that fits their management system. No pest management system, by itself, will be utilized.
- evidence that we are aware of, and sympathetic with other specialities and problems and how these all have a part in a successful game plan.
- good inventoreis and meaningful interpretation for them to measure against their objectives. Otherwise, as Harry Yates said several years ago, pest control practices may be protecting a crop of unknown value from imaginary dangers! And the referees will blow their whistles.
- public relations. We - researchers, pest control specialists and pest management advisors must sell our products. Most importantly, we including land managers, must teach those potential referees the objectives of the game. Convince the public that our game plan is worthwhile. Then there will be fewer whistles.

Dave Overhulser

In 1979 the Northwest Forest Pest Action Council mailed 500 questionnaires to land managers in Oregon and Washington seeking their views on priorities in forest insect research and management. Those surveyed were asked about the relative importance of various insect problems, whether current research addresses their most pressing concerns and if foresters presently receive adequate pest management assistance. Responses from the east and west side of the Cascades were evaluated separately.

Major findings were that (1) westside foresters view the Sitka spruce weevil and cone and seed insects as principal pests; (2) eastside foresters regard bark beetles and defoliators as major problems; (3) both groups viewed large-scale research programs focusing on individual pest problems very favorably; (4) user groups were least satisfied with pest management support relating to impact estimates and insect control; and (5) a majority of respondents in industry, Bureau of Land Management and Bureau of Indian Affairs believed they are not receiving adequate training in applied pest management.

The results of the questionnaire provide guidance on forest insect research needs and pest management priorities in Oregon and Washington. Effective response to problem areas identified in this survey will depend on changes in administrative emphasis among agencies with pest management responsibilities and upon the availability of funding for research.

PANEL 3: THE MT. ST. HELENS ERUPTIONS AND THEIR SIGNIFICANCE TO
FOREST ENTOMOLOGY

Moderator: Boyd E. Wickman

Panelists: Boyd Wickman, Rick Johnsey, Dave Overhulser, Gary Long

Summary: A slide show covering the following subjects was presented.

- a. Overview of the eruptions and resulting forest destruction damage, and recovery. Types of forest insect research underway. Boyd Wickman, Forest Service, Forestry Sciences Laboratory, Corvallis, Oregon.
- b. Damaged timber and the potential for build-up of Douglas-fir beetle and ambrosia beetle populations. Rick Johnsey, State of Washington DNR, Olympia, Washington.
- c. Forest management problems facing a private timber company. Dave Overhulser, Weyerhaeuser Co., Centralia, Washington.
- d. The effect of ash fallout on various insect communities including the larch casebearer. Gary Long, Washington State University, Pullman, Washington.

PANEL 4: ARE WE MAKING ANY PROGRESS?

Moderator: R. W. Stark

Panelists: Various "old-timers: who do not want to be identified as such and several students whose lack of respect for age and wisdom renders them nameless.

SUMMARY

49% No; 51% Yes. There is room for optimism given the articulateness, enthusiasm and obvious intelligence of the students and newcomers present. There is, however, also concern that much research is repetitive and there is an apparent lack of consideration for past research in research planning and application.

WORKSHOP: SCOLYTID PHEROMONES: WHAT NOW, WHAT NEXT?

Moderator: Tom Payne

The workshop was a success based primarily upon the excellent format set forth by John in his January 30, 1981, letter and the enthusiastic participation of the members. Thirteen individuals signed up for the workshop, and fifteen participated including Ron Billings, George Evans, Bill Funkhauser, Dick Heath, Staffan Lindgren, Ross Miller, Bob Miyagawa, Dave Overhulser, Tom Payne, Randy Randall, Lee Ryker, David Schultz, Terry Shore, Paval Svihra and Dave Wood.

Discussions took place under the following headings:

1. Any hot results that the world should know about. Most of the discussion centered around the Norwegian and Swedish effort to mass trap Ips typographus. Dave Wood has provided advice to the effort and shared his insight with us. The effort ("campaign") represents the largest single attempt to suppress a forest insect pest population on an operational basis using behavioral chemicals. The campaign began in 1979 and has just gone through the second year. Over a million traps have been deployed with many millions of beetles trapped. An estimated one trap/two infested trees were deployed. The mean trap catch for the 1980 season was approximately eight thousand beetles/trap. This was up over 1979. Tree mortality does not appear to have lessened over the last three years. In 1978, prior to the campaign, approximately three million trees were lost. Similar losses have been reported for 1979 and 1980. It is difficult, if not impossible, to evaluate the success of the campaign since no controls were established. The ambitious effort resulted from a series of events which allowed for pest population build-up and left no other possible means of direct suppression. Specifically, de-barking as a routine procedure was stopped some years back, and beetle populations began to increase. In addition, the 1969 and 1970 blow downs provided an unlimited supply of ideal host material for population build-up. Considerable new research is still needed on the problem, specifically in the areas of basic behavior, pheromone composition, trap efficiency to prelude natural enemies, and general population dynamics.

2. Perceptive observations on the "rosy outlook" or the "sorry state of affairs" for current research efforts. In general the current research efforts looked "rosy". That is, several different investigations are moving closer to application in the early stages. Specifically, anti-attractant work with the Douglas-fir beetle, western pine beetle and southern pine beetle look promising. The "sorry state of affairs" seems to rest in two categories, one viewed as a direct result of the other. First, funding is scarce for behavioral chemical research, and second, our supply of good basic behavioral information is scarce. If a remedy is anywhere in sight, it will probably occur after efficacy is shown for those tactics near application. This may be a "catch 22) situation since more basic behavioral research may be necessary before efficacy can be shown.

3. Future research "needs" or "don't needs". Several areas were mentioned:

- a) efficacy of treatment tactics
- b) trap design
- c) elution technology
- d) survey and detection techniques
- e) basic behavior

4. What is the future of pheromones in scolytid management? - The future remains promising in several areas.

- a) barrier trapping for ambrosia beetles
- b) spot disruption for southern pine beetle to permanently or temporarily halt spot spread to allow time for salvage
- c) individual tree protection may be possible for western pine beetle
- d) trapping as a tool along with fungicide treatment and sanitation salvage for Dutch elm disease suppression
- e) disruption for Douglas-fir beetle to prevent build-up in breeding sites
- f) survey for various species

In general, pheromones, will find their most useful place as one of a number of tools and probably not as an end alone.

WORKSHOP: HOW CAN WE SPEED UP THE RETURN OF SURVEY INFORMATION
TO THE LAND MANAGER?

Moderator: H. F. Cerezke

As a framework for discussion five general categories were suggested in which there is opportunity for improvements in transfer of information to the land manager. These include (a) the capabilities and constraints of the agency or persons conducting the survey, (b) the methodology and detail of data collection and analysis required, (c) format of data summary, (d) capability of the land manager to utilize results or to implement action within a certain time frame, and (3) follow-up action plan. Within this framework some specific examples were cited and discussed, representing diverse views in Canada and the United States.

In Ontario work and/or action committees are established to deal with each major problem such as spruce budworm. Each committee consists of 45 people, representing the district forester, OMNR, and FIDS, and meets on a regular basis but with a definite life. The committee functions to identify options, determine information required to make a decision and prepares specific work plans. Since high-value forests are identified, problem tasks can be made site-specific and the information can go directly back to the land manager for implementation. Assessment can also be made after initial survey to continue, to modify, or to recommend areas of research follow-up. It was emphasized that the main strength of the committee was its small size and mandate on specific problems.

Having the province work closely with FIDS in surveying major pests can speed up the transfer of information and ensure compatibility of methodology. Reports of annual loss estimates may also be prepared more quickly. In B.C., two annual forest Pest Review Committee meetings are held to discuss all major insect and disease problems; committee includes provincial, federal, University, and industrial representation.

The unit or district foresters need to be informed at all stages since they make the final management decisions. Where problems arise of company and provincial concern, involvement in the survey by representatives of all three agencies, company, provincial and federal, the information exchange is mutually beneficial since each views the problem first hand and can contribute accordingly. In some cases, having a group of experts at one location (i.e., bark beetle specialists at PFRC) can provide the best interpretation of information and speed up its transfer. Forest Management Planning Act was cited as an opportunity to include specialists such as entomologists and pathologists on the planning team.

It was suggested that computers play a larger role in formulating timber management plans in greater detail and include requirements for yield prediction. Various risk factors might be built into the system so that much of the basic inventory information is already in place when an outbreak is imminent. Thus policy statements and guidelines for action could be made before the outbreak develops.

WORKSHOP: TAXONOMIC PROBLEMS IN THE STUDY OF FOREST INSECT
POPULATION DYNAMICS AND THE DEVELOPMENT OF IPM SYSTEMS

Moderator: Bill Waters

For purposes of this workshop, taxonomy was defined in a broad sense as the recognition and division of a species or species group into entities biologically meaningful to studies in population dynamics and the development of IPM systems, including strategies and techniques of survey and control. Problems arise, in part, from differences in the perception of what is biologically meaningful and differences in the criteria used to define a "species" and to characterize variation within it. Both a "species" and the "populations" comprising it may be defined and bounded differently by the conventional taxonomist, the population geneticist, the population ecologist, and the pest management specialist. It was agreed that, with an emphasis on meaningful and useful, it is necessary to specify (1) the level and aspect of study involved, e.g., variation in morphological characters, pheromone response, disease susceptibility, life table studies, population modeling, (2) the operational range of the IPM system intended, and (3) the level of organization at which the information is to be applied.

The topic then was addressed in terms of the following "problem" areas:

- I. Population dynamics, specifically in the concept and development of life tables and population modeling.
- II. Susceptibility/resistance to toxic chemicals, including measurement and characterization of the variation among different "populations" and changes over time due to treatments.
- III. Susceptibility to microbial agents, including as above the measurement and characterization of spatial and temporal variations and the variability and capability for change in potency of the microbial agents themselves.
- IV. Parasite-host and predator-prey relations.
- V. Pheromone response, in particular problems inherent in the development and use of synthetic attractants for survey and control purposes.

These topics were discussed in some detail, with specific examples, by individuals having experience in each problem area. Conceptual differences in understanding and approach were evident, with a consequent lively interplay of ideas.

WORKSHOP: THEORETICAL RESEARCH - WHAT USE IS IT?

Moderator: A. A. Berryman

This was a free-flowing discussion concerning the value and applicability of theoretical research. It was pointed out that pest management decisions often had to be made without adequate empirical information and that theory provided a framework within which decisions can be made in these cases (e.g., biological control with introduced parasites relies almost entirely on theoretical considerations as do many silvicultural practices aimed at preventing insect outbreaks). The dangers of theory-free empirical studies were also emphasized, drawing attention to the problem of extrapolating beyond the data range. Theoretical investigations often enable the form of relationships to be deduced (i.e. they provide qualitative insights) which, coupled with empirical data, permit more meaningful extrapolation. The group generally felt that theoretical considerations should form the framework, or skeleton, on which empirical data is formulated, the flesh, to create management decision models.

"Theory without fact is fantasy
Fact without theory is chaos"

Moderator: Jim Colbert

Participants: Nick Crookston, Jack Barry, Alan Thomson

Nick Crookston stated that for a pest-management model to be implemented requires communication between the researchers who formulated the model and the forest managers who will use it. The manager needs to know: 1) How the model was formulated and that experts in important disciplines were well represented in the formulation process. 2) What empirical data have been used to calibrate the model components and if all of the available data have been used; 3) How well the model predicts.

Although development of models is the job of the researchers, they need the help of managers and planners to assure the utility of the final product. And users need the help of researchers to assure proper local calibration and validation.

Jack Barry, speaking for John Wong, also of the Methods Application Group emphasized full utility of the models will require: 1) Support by management of their continued development. 2) Compatibility for the systems on which the models will be used; 3) "User-friendly" computer access; 4) Public review of the models.

In the discussion, the following points were made: 1) Models require an organizational unit (program or project) that will maintain the complete model package. 2) Managers are interested, in using models for example, in northern Idaho the Douglas-fir Tussock Moth-Stand Prognosis-Cheapo model package is being used. But an important key to the acceptance of models is a well-designed and advertised demonstration of their usefulness. 3) Models should show the various qualitative aspects of the system. Simple graphs should be the end product. The user has to accept responsibility for implementation. Detailed, mechanistic models will be discarded at that point. 4) The system must be capable of operating from a standard inventory. Users must have good, detailed instructions on how and what inventory is required. For example, Stand-Prognosis Model required new inventory data to give full analyses requested by forest managers; so field crews were increased by one person. The answers were interesting enough to managers for them to be willing to pay for the extra staff. 5) Models should not be oversold; users need to realize that because a model will never give perfect projections every time it is used.

Consensus: Someone must be available to work with managers--to show them how to use models, to explain the differences, and to interpret details of simulation output. This will require a permanent full-time commitment from top management. Continuity was pointed out as essential to the process. And the person must have a firm background in research and have worked closely with managers to fully appreciate their needs.

* Dr. Thomson was not able to take part in this panel because of travel restrictions but contributed in writing and by telephone.

WORKSHOP: LEPIDOPTERAN PHEROMONES: WHAT NEXT?

Moderator: Gary Daterman

Participants: Dave Nielson, Skeeter Werner, Dave Overhulser

In addition to Daterman, discussion leaders included Dave Nielson of Ohio State University, Skeeter Werner, USFS, Fairbanks, Alaska, and Dave Overhulser, Weyerhaeuser Co., Centralia, Washington. About 35 members were in attendance, and participated in active discussion of a wide range of pheromone-related subjects.

Dave Nielson began the session with a fascinating set of slides and discussion of the clearwing moths (family: Sesiidae). Classical chemical analyses of the pheromones of two sesiid species led to the discovery of extensive interspecific pheromone attraction within this family. These pheromones have been a boon to sesiid taxonomists, and as a result the speciation and distribution of sesiids are now better understood than ever before. Neilson also sees strong potential for management application of pheromones in small horticultural areas such as parks, nurseries, ornamental landscapings, etc.

Dave Overhulser stressed the interest of industrial forestry in controlling pests of the higher value resources. Specifically, seed crops and seedlings in nursery beds were mentioned as extremely high value resources needing improved protection. Pheromones are being considered as important tools, both as control agents themselves and for use in monitoring systems to improve timing of more conventional control agents. Work is currently underway on development of the pheromone of the cranberry girdler, Chrysoteuchia topiaria, to suppress damage to Douglas-fir nursery seedlings; and, on pheromone identification of Douglas-fir cone worms, Diorcyctria spp. for use in monitoring and suppression strategies.

Skeeter Werner discussed his continuing and future work on large aspen tortrix, Choristoneura conflictana, in Alaska. Pheromone baited traps are under development as tools to measure populations and predict damage in areas of high value trees. Also, in 1981 or 1982, he plans to test the pheromone as a control agent using the mating disruption strategy. C. conflictana infestations are in pockets of aspen surrounded by various species of non-host trees. This partial isolation of plots offers an excellent testing situation because immigration by females from outside the plot will be minimized.

Daterman discussed progress in use of pheromone-baited traps to monitor Douglas-fir tussock moth populations, and in registration by Hercon Division of Health-Chem Corp. and ConRel Division of Albany International Corp. of the western pine shoot borer, Eucosma sonomana, pheromone as a commercial control agent. The emphasis of future research will be on further development of the tussock moth pheromone as a control agent, and on identification and development of Diorcyctria pheromones for use in pest management applications.

WORKSHOP: REVIEW OF CURRENT LARCH CASEBEARER STUDIES

Moderator: Scott Tunnock

Participants: Christine Niwa, Steve Laursen, Richard Nathanson,
Garrell E. Long, Ron Stark, and Don Burnell

Five oral presentations were given and four reports were summarized by the moderator. Tunnock stated that 1980 aerial surveys for casebearer defoliation were hampered by needle diseases on larch. Potlatch Timber reported that they will continue to distribute Agathis pumila. Ryan reported that Pacific Northwest Experiment Station continued to rear and release exotic parasites. The effects of acephate, malathion, and dimilin were tested against parasitized casebearer larvae, and acephate and malathion caused high mortality. Bacillus thuringiensis killed only 57.4 percent of test larvae. Boise Cascade reported that they released 42,000 Chrysocharis laricinellae and 391 Diadocerus japonicus in 1980. The Pacific Northwest Region reported they will release Chrysocharis and Agathis in the Metolius-Camp Sherman area in 1981. Long stated he and Ryan studied the effects of volcanic ash on casebearers and parasites. He showed some data on increment loss based on larvae/100 spurs. His study on the parasite complex of casebearer in northern Idaho resulted in three new distribution records. Laursen gave a presentation of his investigation of the effects of casebearer defoliation on growth and development of juvenile mixed species larch stands. Niwa explained the distribution of parasites she found in northern Idaho and Montana during 1980. Nathanson presented some results of his 1980 work with the larch casebearer.

A copy of the minutes in detail were sent to each person attending the workshop.

WORKSHOP: APPLICATIONS OF REMOTE SENSING IN INSECT PEST MANAGEMENT

Moderator: John W.E. Harris

Participants: Rene Alfaro, Fred Hain, Peter Hall, Dick Heath, Bill Ives, Garland Mason, Ben Moody, David Schultz

John Harris described how pest surveys are regularly conducted in BC by sketch-mapping on 1:250,000 and 1:125,000 maps. Visual observations, by staff familiar with the affected areas both from the ground and air are supplemented by hand-held 35 mm and 70 mm true color obliques. Visual analysis of LANDSAT imagery resulted in only very distinct defoliator damage being detected. Additional work with bark beetle damage using LANDSAT, an 11-channel multispectral scanner and a multispectral image analyser is underway. Preparations are being made to use LANDSAT-D data when available. Other studies are on quantification of defoliation and multistage sampling for bark beetles.

Peter Hall completed a master's thesis on previsual detection of Douglas-fir beetle damage. Three months after attack, before visual symptoms appeared, optical density values showed significant separation of damaged and undamaged classes on 1:1,000 color infrared photography.

Garland Mason indicated that progress on remote sensing of pest damage was slow in the south, mostly because of the scattered, mixed pattern of forest land ownership and because better access permitted information collection by other means. Sketch-mapping is still an important technique, although the use of color photography is increasing. The LORAN-C navigational system is being used to re-photograph plots. Digital analysis of LANDSAT is being explored.

Fred Hain reported on the southern pine beetle program. There are problems with re-locating plots and controlling altitude and camera angle. LORAN-C was used. A digital terrain information system was described useful for mountainous terrain.

David Schultz indicated natural color 1:8,000 transparencies were used in multistage sampling surveys using probability proportional to size.

C.J. Demars (Berkeley) could not attend but submitted a summary of work in California where he is attempting to include pattern as well as density in measuring population size, and to relate these factors to ecological causes. He is using aerial photographs to map tree mortality centers. Data are digitized and plotted by desk top computer to determine if pattern is uniform, random or aggregated.

WORKSHOP: TRAINING PEST MANAGERS - WHAT ARE THE NEEDS?

Moderator: Don Dahlsten

Participants: Paul Buffam, Bruce Devitt, John McLean, Imre Otvos,
Fred Stephen, Jan Volney

Recorder: Mark Linnit

This was a lively workshop and was attended by 35 individuals. The panelists were asked to come with some thoughts on training pest managers, not formal presentations on the topic. Toward the end of the session we realized that we hadn't really defined what a forest pest manager was. The group came to this conclusion after a divergence of ideas were expressed as to the training and experiences of a typical pest manager. We also realized that we were really defining the perfect individual who in real life probably doesn't exist--a wonder woman or a superman.

The group reached a consensus on one item and that was that the forest pest manager should have a forestry background or degree. This viewpoint was tempered a bit later in the session when it was agreed that the ideal person should have a good biological background and the rest of the expertise could be built upon that. Certainly a good grounding in forestry is a necessity. Another important skill was the ability of a pest manager to communicate with foresters and the general public.

The idea was expressed that forest entomologists had gotten lazy with the advent of the synthetic organic insecticides like DDT and had really forgotten all about forest management. With the advent of integrated pest management systems in forestry, the forest pest manager must have a broad base and be concerned with total pest management, not just insects and/or diseases. The pest manager should be capable of working as part of an interdisciplinary team and be versed in hazard rating and prevention. This individual may have to know something about using stand prognosis models and forest economics. All too often we tend to leave forestry out of pest management but it is vital that forestry be part of pest management. The real question to educators is, how do we do this? A number of ideas were expressed, for example, should the individual choose a specialty and stay with it? If teams of individuals were to work on pest problems, then this may work. It was also expressed that individuals crossing over from other disciplines oftentimes make major contributions because of a new and fresh outlook on a pest problem.

The education of the users, the forest managers, was also discussed. There is a need to educate ecologically aware foresters but in many cases students at our forestry schools are not even getting the basics like silviculture and dendrology. Most felt it was important that the forester as well as the pest manager had to have enough background in order to appreciate the complexity of the pest problems.

As the session concluded, we all expressed concern that there would, in fact, be jobs for our ideally trained forest pest managers.

WORKSHOP: CANUSA AT MIDPOINT

Moderator: Mel McKnight

Participants: Ron Stark, Tom Flavell, Bob Talerico, John Harris

The original subject of the workshop was abandoned for lack of interest.

Laura Doliner described her study of the "Fraser Canyon episode" involving a proposed but eventually aborted treatment of a western spruce budworm infestation with a chemical insecticide. This sparked a lively discussion of the decision-making process in such sensitive situations. A key factor in the process seems to be the delivery of appropriate information at all levels, ranging from the interested and concerned public to the ultimate decision makers. Information brokers are needed because the scientific and technical community is often not prepared for the task.

WORKSHOP: PEST MANAGEMENT FOR URBAN TREES

Moderator: D.G. Nielsen

Participants: D.B. Nielsen, R. Gardner, E.R. Hart, J.W. Brewer

Participants considered the current climate for establishing Pest Management as a viable approach for minimixing insect damage to urban trees. The role of pest management as a component of Tree Health Care was placed in perspective, in terms of urban forestry and environmental quality. Speakers stressed the importance of gaining better understanding of insects and insect-host tree relationships before attempting to implement pest management as a replacement for current spraying programs by arborists and pest control operators. Some panelists felt that PCO's and clients may not be ready to accept the tree health care approach until demonstration projects had proven its effectiveness.

A management plan for Vancouver, B.C. shade trees was presented, along with general comments about why urban forest resource management is a difficult challenge. However, there is some acceptance for the pest management concept for urban forests in B.C., although research and extension programs are needed to support efforts in tree maintenance.

Research with mimosa webworm was used to emphasize the need for basic biological studies before a pest management strategy can be optimized. The influence of host nutrition on population dynamics of spruce budworm was explained to focus attention on the importance of knowing how cultural practices influence pest populations.

Panelists and attendees agreed that greater emphasis must be placed on understanding how insect populations respond to changing tree health and how cultural practices can be employed to maintain trees in a "resistant" or "tolerant" mode. However, few researchers are addressing these questions, and there has been little grant support for research on urban forest health care.

WORKSHOP: GETTING A HANDLE ON FOREST INSECT DISPERSAL

Moderator: Roy C. Beckwith

Participants: Dave Greenbank, Gary Long, Don Burnell, Gary Daterman

The informal discussion covered the subject from long-range active dispersal of adults to short-range passive dispersal of larvae. The methods to study dispersal varied from the use of sophisticated technology and biochemistry to the simplistic approach of using interruptive sticky traps.

Dave Greenbank presented some of his work on the eastern spruce budworm. Spruce budworm moth populations are redistributed each summer through moth dispersal. In July, ground-based radar was operated nightly in New Brunswick, Canada, from 1973-1976 to help understand the dispersal process. At the same time, meteorologists monitored wind direction and speed in order to define the pattern of moth movement each night and the seasonal pattern of population redistribution. These latter studies have continued since the shutdown of radar in 1976. It is now evident that in summers with clear sunny weather moth populations will tend to accumulate in New Brunswick, while in summers with overcast skies as many moths may be blown out to sea as enter the Province from the west. Marine wind flows from the south and east coasts are responsible for the concentration and containment of budworm moths within the Province.

In 1952, J.G. Skellam developed a model for randomly dispersing populations with which he showed that the radius of an area occupied by a fixed proportion of the total population was linearly related to the amount of time during which the population had been dispersing. Gary Long used that model in 1977 to describe dispersal of larch casebearer in northern Idaho. Since then, he has found the model to apply equally well to a description of the results of dispersal by eastern spruce budworms, western budworms, gypsy and the mountain pine beetle. The model is very robust and allows prediction of when an insect outbreak may occur in susceptible stands.

Don Burnell explained the use of sticky traps to sample early larval dispersal of the western budworm. The rope/pulley system allowed traps to be placed at different heights within the crown canopy and be easily examined at frequent intervals. In north-central Washington, traps were placed at 90 m, 6 m, and 2 m above the ground. Mean trap catch was consistently greater for the higher traps throughout the dispersal period. Off-tree dispersal occurred in a larger number of 3rd instars than was expected. Cumulative trap catch plotted over degree-days produced 3 linear segments with 2 distinct bends that are essentially related to the 2nd, 3rd, and 4th instars.

Gary Daterman discussed the trapping of adult insects with pheromone baited traps as a means of studying dispersal. Usually this is accomplished by a mark-recapture approach with released insects. Valuable information may also be obtained by placing traps varying distances from isolated concentrations of field populations. Captured insects in such experiments reflect dispersal potential. It must be kept firmly in mind, however, that when sex attractants are used in such studies, the captures represent only the behavior of the responding sex. The dispersal of flying adults can also be helpful for monitoring population densities. Many species are strongly aggregated in their distribution during the larval stage, and this can greatly complicate sampling problems. Once adults take flight, however, their distributions generally become more random so that fewer samples are required to characterize the population over extensive areas.

WORKSHOP: LOCAL BENEFIT/COST METHODS FOR BUDGET CONSTRAINED IPM

Moderator: Tom Bible

Three topics were presented and discussed: (1) Determination of which insects to survey among several species and the level of surveillance when survey budgets are inadequate to survey each insect species on a forest; (2) Regional economic impacts other than direct volume losses attributable to insect activity; and, (3) Implications of social costs associated with IPM programs.

Topic (1) was based on Gregg & Twardus (1981) framework. Evaluating the cost of an insect survey against the benefit of a survey in terms of the value of survey information to managers was discussed. Value to a manager is determined according to forest losses that could be avoided if additional information about an insect were forthcoming. Specifically, if damage from a particularly destructive and rapidly developing insect could be controlled by early action, an insect survey that indicated a probable course of insect activity early in an outbreak would have higher value than early and comprehensive information about an outbreak expected to develop more slowly. One challenge then is to link insect population dynamics models to available sample information that would indicate the future course of insect populations. Another challenge is to link insect models to damage projections.

Topic (2) was related to current research linking insect impact to forest planning. The conduit for impacts is through changes in timber yield tables leading to impacts on forest allowable cut and even flow harvest objectives. Insect impacts leading to forest plan changes in the public sector may also lead to regional economic disruption. For example, if a private producer has positioned a mill in anticipation of planned public harvest and insects alter the plan, losses could occur to the mill owner and to the surrounding region through regional economic base losses.

Another local impact considered was potential loss to private woodlot owners resulting from insect damage salvage sales on public ownership. Even if a private owner suffered no direct timber damage, salvage sales can depress stumpage price for all sellers including those with undamaged timber. Private owners can then either sell at a loss in the current market or withhold harvest and incur a loss equal to the difference between current "pre-salvage" prices and the discounted value of future "post-salvage" sales.

Topic (3) addressed subjective losses to certain individuals who oppose many of the accepted methods of IPM. In general, those individuals are persons who are not opposed to timber management per se, but may nevertheless oppose specific IPM methods such as chemical or biological control. It can be shown that subjective losses will differ as a function of an individual's perception of who holds de facto management rights to public forests. Following accepted rules of valuation, it can also be inferred that public forest policy that seeks to involve the public in public forest management can increase subjective losses associated with some IPM options for individuals who are opposed to those options.

There is some evidence that those losses may be measured in terms of virulent local opposition to forest management programs in the U.S. Pacific Northwest (Bible (1981)) and elsewhere. If that evidence is supported it would seem imperative that forest managers and entomologists present a clear and accurate case for IPM in the forest management and planning process. Subjective losses to individuals might be reduced by correcting many misleading and misunderstood notions about IPM held by the general public. Otherwise, it can be demonstrated that subjective losses to individuals and opposition to some IPM alternatives may increase as more of the public is brought into forest planning in the public sector.

Bible, T.D. (1981), "IPM, Ownership Rights, and Public Welfare", Oregon State University.

Gregg, T. & D. Twardus (1981), "Detection and Evaluation Procedures for Potential DFTM Outbreaks in the Pacific Northwest", U.S.D.A. Forest Service, Portland, Oregon.

WORKSHOP: COMPONENTS OF PEST MANAGEMENT SYSTEMS FOR BARK BEETLES

Moderator: Les Safranyik

Participants: Bob Thatcher, Ron Billings, Nick Crookston, Mark McGregor,
Ron Stark

The workshop started with the moderator's definition of pest management and its components. "Pest management (PM) was defined as follows: PM is the science of reducing pest problems by actions selected after the life systems of the pests are understood and the economic as well as the ecologic consequences of these actions have been shown to be in the best interest of mankind". PM for bark beetles should be an integrated part of forest resource management. Therefore, many aspects of the host/beetle interaction and the socio-economic aspects of impact need much further investigation. Bob Thatcher, in reviewing the southern pine beetle (SPB) program, emphasized the need for an integrated, multidisciplinary approach to research, more attention to the host/beetle relationship, other bark beetle associates of SPB, and to utilization of killed trees. Ron Billings emphasized new approaches to direct control of SPB and the importance of site and stand factors in predicting expansion of infestations as an important component in current management programs. Nick Crookston emphasized the need for incorporating information on bark beetle epidemiology into the management planning process. This was done with some success for the mountain pine beetle (MPB) in lodgepole pine by coupling the MPB dynamics model to a stand prognosis model. Mark McGregor stressed the importance considering forest values other than timber and the need to utilize all available know-how in managing bark beetle problems. He illustrated this concept with the operational management of MPB in lodgepole pine in the Intermountain Region. Ron Stark, speaking from the point of view as a research manager, pointed out that the growth of IPM from entomological background has, somewhat unfortunately, caused it to become established in the same "homes" as our traditional "Crisis Pest Control". In government agencies the best place for IPM would be in the Planning Units. Management of PM studies is difficult. The problem lies not so much in the components or practitioners of the system but in the milieu in which it has developed.

WORKSHOP: GENETIC VARIABILITY OF FOREST INSECT POPULATIONS AND
IMPLICATIONS FOR IPM

Moderator: Molly Stock

Participants: Kareen Sturgeon, George Harvey, Jacqueline Robertson,
John DeBenedictis

Kareen Sturgeon discussed the role of host diversity in preventing increasing specialization of insect populations to one host type. Differences in the extent of biochemical diversity present in different parts of the range of ponderosa pine can influence the feeding habits of the bark beetles feeding on the pines in the different geographic areas. Utilization of different host trees is reflected in the genetic structure of mountain pine beetle populations. Although beetles emerging from one host type possess genotypes better suited for survival in that host type, mating among beetles from different host types disrupts this adaptive process each generation. Implementing host diversity as a management tool may be feasible now in seed orchards and in plantations but is likely to become an important part of natural stand management only when stands are intensively managed.

George Harvey reviewed variation in several morphological and physiological characters described for Choristoneura fumiferana. Variation in larval head and prothoracic shield colors and mean weight of initial eggs are related to geographic parameters. Using color scores from more than 8500 C. fumiferana from 197 general locations across Canada, a significant geographical trend from east to west was found. Most of the variation in shield colors was due to longitude. Mean weight of eggs in the initial egg clusters laid by females is, to a considerable extent, genetically controlled and has biological significance. Survival through dispersal and subsequent establishment on food is greater for large eggs than for smaller ones provided the duration of storage has been long enough to provide some stress to survival. Mean egg weight appears to be an independent variable from pupal weight and fecundity and varies directly with latitude. Probably the heavier eggs in higher latitudes are necessary to enable the insect to survive the longer winter period. Consideration of the reduction of numbers of progeny required by large egg weights should be incorporated into life tables and models.

Jackie Robertson discussed variation in response to insecticides among field populations of forest defoliators. Considerable variation in response occurs among populations with no previous record of spray treatment. Earlier tests on Douglas-fir tussock moth populations revealed a two-fold difference in response to carbaryl among four populations. These differences have an underlying genetic basis. Repeated treatment by chemical control agents may lead to further modification of response levels. Recent tests of western spruce budworm populations with different spray histories underline the necessity for prespray identification of response levels. Larvae from an area with a history of intensive spray treatment were 7 times more tolerant of carbaryl treatment than larvae from an area that had been less intensively treated. The implications for pest management were reviewed.

John DeBendictis reviewed recent studies of the systematics of western budworm species. Because they are difficult to differentiate, taxonomic decisions are based upon pheromone attraction, larval and pupal coloration, and preferred larval foodplant rather than adult morphology. California species exhibit increasingly greater morphological variability as one proceeds northward. This variability appears highly correlated with potential for outbreak and adaptability to non-preferred host trees.

WORKSHOP: WHEN CAN BIOLOGICAL CONTROL CONTRIBUTE SIGNIFICANTLY TO PEST MANAGEMENT?

Moderator: Imre Otvos

Participants: Jim Muldrew, Stu Whitney, Bill Ives, Fred Stephen, Mark Linit, Alan Berryman, Les Safranyik

The workshop consisted of two structured presentations, followed by informal discussions by the participants.

To present a framework for the workshop it was pointed out that the interpretation of two words in the title: can and significantly will determine the discussion and conclusion of the workshop. This was followed by a definition of biological control (the use and encouragement of introduced or natural living organisms, such as predators, parasites and pathogens for the reduction of pest populations and their damage), and of pest management (the integration and implementation of a variety of control techniques including biological control, genetically resistant host trees, modification of environment and chemical pesticides) to reduce pest damage to tolerable levels. It was emphasized that biological control should not be looked upon as a universal panacea for all insect pest problems; it may completely solve problems with some species and may be of little use against others. The three main kinds of biological control approaches: 1) Classical (introduction of natural enemies of non-native (exotic) pests). 2) Conservation and Augmentation, and 3) Inundative and Inoculative Releases were briefly described with specific examples.

Jim Muldrew gave the first presentation on parasite introduction against the larch sawfly, Pristiphora erichsonii. Several species of parasites have been imported into Canada, against this introduced pest of which two: Mesoleius tenthredinis and Olesicampe benefactor deserve special attention. M. tenthredinis was introduced from Europe between 1910-1913 and was credited with the control of several larch sawfly outbreaks. However, a strain of larch sawfly, capable of encapsulating the eggs of M. tenthredinis appeared in Manitoba and subsequently spread across Canada reducing the effectiveness of this parasite. This strain is believed to have originated from the initial deployment of sawfly cocoons from Europe. The cocoons were placed in sawfly infested stands in the field in Manitoba for M. tenthredinis to emerge. Probably some M. tenthredinis resistant sawfly adults also emerged in the field. Later a Bavarian strain of M. tenthredinis was introduced because it could overcome host resistance and could pass this ability to the progeny with "native" crosses. From 1961 to 1966 Olesicampe benefactor, an ichneumonid, was introduced at various locations across Canada. This introduction can be considered as successful in that its dispersal rate is satisfactory, percent parasitism has risen to very high levels and defoliation of larch was substantially reduced. However, a native hyperparasite Mesochorus dimidiatus, of the balsam fir sawfly parasite complex poses a threat to effective larch sawfly control by O. benefactor although it did not prevent the build up and spread of O. benefactor from the release sites.

Stu Whitney gave the second presentation on his work on the use of Beauveria bassiana to control the mountain pine beetle (mpb). Stu reminded us that although research on biological control has been in hiatus until recently, largely due to "miracle chemical" pesticides developed during the 1940's, bio-control is operating well in our forests, for example, Dutch elm disease vs. elms, Endothia blight vs. chestnuts, blister rust vs. white pine and mountain pine beetle (mpb) vs. lodgepole pine. A brief description of an unexplained mpb brood mortality, observed in 1980 followed. Stu emphasized that the catalogue of possible bio-control agents for major forest pests is likely not yet complete.

However, we need not wait for this list of candidate bio-control agents to be completed before making attempts to use what information we already have. The strategy of using Beauveria bassiana, a well known and extensively studied entomopathogenic fungus, as a bio-insecticide for direct control of mpb was described. The main approach is to produce a lethal beetle disease in "hot spot" infestations before new generation parent adults could reproduce. Using caged beetles on bolts and trees with topical (man made) and autoinoculation with the pathogen, there was 40% survival of topically inoculated beetles that penetrated live trees compared to only 5 to 10% in bolts. This suggests a live tree factor working against infection and disease development. Autoinoculation studies showed that a dust application of 5×10^{13} Beauveria spores per ft² did not result in beetles effectively inoculating themselves. Use of Beauveria in the management of mpb must await additional information on beetle autoinoculation and on the significance of live tree persistence to mycosis.

Bill Ives commented on the effectiveness of O. benefactor by saying that before the introduction of this parasite it was easy to find larch sawfly infestation, once sawfly population started to increase. However, after the introduction it was difficult to find a sawfly infestation until the hyperparasite transferred from the balsam fir sawfly parasite complex. Ives also mentioned his virus work on the forest tent caterpillar; highly promising lab results were followed by less than promising field trials.

A lively discussion followed on the use of naturally occurring entomopathogens, particularly viruses in forest insect control. Although all participants of this discussion accepted the potential for entomopathogens to mutate to one affecting vertebrates, the probability attached to this possibility varied greatly among the speakers. In spite of the example of a bacteria, Bacillus thuringiensis, which has been used on vegetable crops, grown for human consumption for 20 + years and showed no evidence for such mutation, some people felt that the use of viruses would present a greater hazard. Bill Ives expressed concern while Alan Berryman voiced his reservation in stronger terms. No consensus was reached on this issue.

Fred Stephen and Mark Linit described how modeling can be used in evaluating the role of natural enemies. Using a computer model simulating southern pine bark beetle population dynamics they found that reducing relatively little of the effect of predators and parasites (these natural enemies were estimated on a tree basis to cause about 25% mortality of the brood) resulted in substantial increase in both bark beetle population and subsequent tree mortality.

Alan Berryman talked about some of the theoretical considerations (interaction among host plant, pest and natural enemies functional and numerical response of natural enemies), and how these might be used in selecting a natural enemy for introduction or manipulation.

Les Safranyik mentioned several examples of other than the introduction of exotic species which may be used in pest management.

The role of natural enemies in insect control has potential for "manipulation" in an integrated pest control approach. The amount and kind of support for biological control will determine when it will reach the stage that it can contribute significantly to pest management.

WORKSHOP: CAN WE ADEQUATELY DEFINE THE IMPACT OF GRAZERS ON
FOREST TREES?

Moderator: Garrell E. Long

Participants: Rene Alfaro, Nick Crookston, Steve Laursen, Allan Van
Sickle, Boyd Wickman

The question is composed of two parts: statistical definition of impacts, short of tree mortality, and whether such definitions are of high enough accuracy and magnitude to be of use in timber management.

It is often obvious that grazing by insect defoliators influences tree growth. Ready examples include firs and larch trees which show apparent decreases in radial increments in years during which the historical record indicates there were outbreaks of Douglas-fir tussock moth or western spruce budworms, or larch casebearer, respectively.

But how much of the loss in potential growth can be truly blamed on the defoliators? As stands and trees age, productivity is expected to decrease as interplant competition increases and total biomass approaches climax levels. Furthermore, canopy closure and overshadowing influence tree form, so that measurements taken at one location along the bole don't necessarily reflect growth at the other levels.

There is some evidence that trees may tolerate as much as 40% defoliation before radial growth significantly decreases. There is also evidence to suggest that when tree mortality does occur as a result of heavy defoliation, radial increments of the remaining trees increases.

Current approaches to marrying the effects of defoliation on single trees with stand management include extension of the DFTM tree defoliation model and the stand prognosis model. Factors which need to be measured with greater accuracy are the amount of defoliation experienced by a tree (i.e., the volume of foliage present as compared with the potential volume of foliage on the tree) and foliage quality (e.g., in the tussock moth program, the relative amounts of new and old foliage).

When these factors can be specified, the growth and mortality of individual trees can be explained in terms of defoliation levels as well as competitive relationships among neighboring trees.

WORKSHOP: MOUNTAIN PINE BEETLE MANAGEMENT WITH REFERENCE TO
CONSTRAINTS FROM OTHER RESOURCE AGENCIES.

Moderator: M. D. McGregor

This workshop was attended by 11-13 participants. A discussion was held about constraints or concerns one should consider during management of mountain pine beetle infestations.

Significant concern was expressed about time involved and requirements put upon purchasers of timber sales in high hazard lodgepole pine stands. Often road requirements, skidding restrictions involving soil compaction and slash cleanup make many sales deficit.

Concern was expressed about protecting riparian areas for scenic value, wildlife, etc.; and critical habitats such as avalanche chutes, whitebark pine stands, denning sites, food types, mesic sites, through proper silviculture prescriptions in areas managed for threatened or endangered species such as grizzly bear and timber wolf.

Prescriptions for high hazard lodgepole pine stands must take into account the cover: forage ration, number, location and closure of roads, thermal cover on winter range, cattle grazing on summer and winter range, number and arrangement of clearcuts, destruction of elk wallows, elk calving areas, slash disposal, scarification, compaction of soil and regeneration in elk management areas.

Close cooperation must be maintained among personnel of Forest Pest Management and other Federal, State and private agencies to properly manage stands to prevent outbreaks of bark beetles or other pests.

Concern was expressed by several individuals about nonmanagement of mountain pine beetle infestations in roadless, primitive, wilderness and National Parks. These areas not only serve as a reservoir of breeding bark beetles which infest stands managed for timber, but also result in a hazardous fuel buildup.

R. S. Miyagawa discussed the concerns of fire and management of mountain pine beetle infestations.

Fire and beetles are both natural phenomena in pine forests. Beetles kill trees resulting in a hazardous fuel buildup. Given proper weather conditions and ignition source, fire then comes along to prepare the site for the next generation of pines. This continuing process no doubt has always existed in our western pine forests.

Man, in his wisdom, has attempted to utilize pine forests for his own needs. For example, the east slopes of the Rockies in Alberta are used for recreation, watershed and a source of wood products. Man has therefore chosen to perpetuate the forest beyond nature's normal rotation period. Thus, protection agencies were organized to extend the life of the forest.

Fire management agencies are very fearful of vast beetle killed areas as it would be almost impossible to control any conflagration given the proper weather conditions.

Burning beetle infested material may be the best sanitation process, however, other values are often endangered during a wildfire.

Unless some major action is taken to counteract the cyclic beetle infestation problem, the protection organization could always be in a no-win situation. It is therefore imperative that some form of long-term management be initiated which could get these forests out of this vicious cycle and yet enhance man's use.

WORKSHOP: SEED ORCHARD-PEST MANAGEMENT

Moderator: Gordon Miller

Participants: Mary Ellen Dix, John Dale, John Barry

The moderator opened the workshop, attended by 25 people, by noting the lack of researchers in the field. As a guideline for the workshop, pest management was defined and the requisites for pest management and special attributes of seed orchards that allow for development of pest management were present.

The moderator then presented a summary of the state of pest management in Douglas-fir seed orchards in British Columbia. Seed losses have ranged from less than 10% to more than 95%. The life histories of most of the major pests are known. Two exceptions, Dioryctria spp. (coneworms) and Leptoglossus occidentalis (cone bug) are currently under investigation. Quantitative sampling techniques for predicting damage by Contarinia oregonensis (cone gall midge) are being developed. The pheromones of Barbara colfaxiana (cone moth), C. oregonensis and Dioryctria abietivorella are being identified. Attempts are also being made to identify host attractants from Douglas-fir. Several insecticides have been tested against cone and seed insects but none were consistently effective. Delayed flowering can reduce damage but is not reliable because of the effects of weather.

Mary Ellen Dix reported on chemical control trials against Dioryctria disclusa on red pine. Granular furadan applied at rates up to 34 gm/in dbh was not effective. Acetate (2lb/100 gal) showed promise but needs testing in a heavy infestation. Analysis showed that acetate persisted on or in cones for 15 days. The biology of Lignoides biscoffi (ash seed weevil) is under examination.

John Dale reported on a trial of Mauget^R injectors containing Meta-Systox-R[®] for increasing seed production in Douglas-fir. The injectors were inserted into trees when the flowers were open, 1 injector per 1-1.5 in dbh. Insecticide uptake by the trees was not a problem. The treatment was effective against C. oregonensis but less so against Megastigmus spermotrophus (seed chalcid). The injector system caused a dead spot in the cambium around the insertion point.

John Barry summarized recent trials of aerial applications in southern pine seed orchards. Aerial applications of Guthion^R and Pydrin^R (a synthetic pyrethroid) effectively controlled damage to cones, D. disclusa being the most damaging insect. Distribution of insecticide is often uneven, a factor that can be countered with good application strategy. Aerial applications are much faster and may be safer than ground-based applications.

WORKSHOP: WHAT'S NEW FOR THE 80's?

Moderator: Tom Flavell

Participants: Bill Waters, Karel Stoszek

It would appear from the discussion during this workshop that what's new for the 80's really isn't new at all in terms of conceptual ideas for dealing with pest problems. Rather, what's new is the evolution of electronic technology to the point where implementation of useful pest/forest management model systems is becoming a practical reality. During the rest of this decade the art and science of forest entomology will be revolutionized as it enters the "age of information".

Before it can do so, numerous organizational problems and barriers to full implementation must be overcome. At the forest level, pest management specialists must have greater involvement in the forest planning process. They must have a better understanding of the total process for integrating information and must begin to view pest/host relationships as integral part of the forest ecosystems not as a separate entity. Further, pest management strategies and tactics must tie in with existing management practices, and as thus are dependent upon clear forest management objectives. Without these the practice of pest management quickly becomes meaningless.

Accomplishing these objectives will depend to a large degree on some institutional and personnel changes. Organizational structures which deter implementation of new technology must be changed, particularly those that prevent full participation of experts in the planning process. Budgetary planning and the fiscal allocation process must be supportive of operational pest management programs on a continuing basis. Pest management practitioners must be re-educated to make use of the emerging technology and to broaden their knowledge of silviculture or "host" management. The reactive role that has been the hallmark of pest control in the past must change to a planning role if true pest management is to become an integral part of forest resource management.

WORKSHOP: SAMPLING SPARSE INSECT POPULATIONS

Moderator: W. Jan A. Volney

Participants: Tom Maher, Fred Hain, Ann Hajek, Gary Daterman, Bill Ives

Standard statistical procedures may be used in sampling sparse populations. However, cost dictates that simple procedures which are efficient, accurate, sufficiently precise and simple be developed. Real progress in this area can only be made with a thorough understanding of the natural history of the organisms investigated. The specific applications of this biological information in the design of sampling procedures are: a) the definition of the sampling universe; the habitat requirements of sparse insect populations may be quite different from those of dense populations, b) the level of significance desired; since most of these studies are at the exploratory stage a high probability of type I error (Ca 10%) may be desirable if there is a risk of not detecting important differences at lower values, c) the level of precision necessary; population changes of 10% are generally unimportant in sparse populations where densities are measured in logarithms (designs which detect changes in $\log N$ of ± 1 may be more realistic), d) the methodology used in assessing population levels, misidentifications are troublesome at low densities.

Studies of damage by lodgepole terminal weevil on lodgepole pine recently initiated by Mr. Tom Maher (UBC) suggest that a large amount of material must be examined to assess the physical impact. Problems with misidentification seem unimportant.

Dr. Fred Hain (N.C. State Univ.) suggested that effective use may be made of historical records, aerial surveys and visits to currently infested trees in studying low levels of the southern pine beetle. These populations are often associated with Ips. spp, however.

Ms. Ann Hajek reported on the work by Prof. Don Dahlsten (UCB) in obtaining empirical data on selected arthropods associated with the Douglas-fir tussock moth on white fir. Parameters associated with distributions describing their occurrence are being estimated. This information will be used in simulation studies of a variety of sampling designs. The development of a pheromone trapping system which is used to monitor changes in Douglas-fir tussock moth populations was described by Dr. Gary Daterman (PNW-Corvallis). This method has the appeal of being comparatively inexpensive and seems quite reliable. Dr. Bill Ives (CFS-Edmonton) described the use of light trap catches coupled with a sequential sampling procedure to assess the risk of damage to recently planted nursery stock by Phyllophaga spp.

THIRTYSECOND WESTERN FOREST INSECT WORK CONFERENCE

Minutes of the Final Business Meeting

Banff, Alberta, March 5, 1981

Chairperson Buffam called the meeting to order at 8:00 a.m.

Minutes of the initial business meeting were read and approved. The treasurer reported a balance of \$224.71 (U.S.) funds and \$3295.24 (CAN) funds as of March 5, 1981. Approved as read.

A motion was made and approved to hold the 1983 WFIWC in California with USDA Forest Service, Region 5 as hosts.

John Dale emphasized a combined forest insect and disease work conference would be desirable. John Laut suggested that timing of such a conference is important because of the annual scheduled meetings of the two groups, i.e., WFIWC in March and WFDWC in September. There exists the possibility that one group would have two meetings in the same fiscal year.

Roy Shepherd said a joint committee was established in the past to plan joint work conferences. A motion was made to investigate the possibility of a joint conference in the near future. Motion was tabled.

Stu Whitney emphasized that a good deal of sound planning is needed in order to have a successful joint conference with lead time of at least two years.

Nominating Committee - The committee nominated John Laut to fill the councilor position vacated by Bill Ciesla. A motion was made to close the nominations and John was unanimously elected for a 3-year term (1981-84).

Common Names Committee - No report. Chairperson Buffam tabled the proposal for rule changes until a member of this committee is present at a business meeting.

Ethical Practices Committee - Chairperson Molly Stock indicated that several candidates were trying hard to qualify for this award but only one person had outstanding qualifications. Tom Payne in his usual manner humbly accepted the award and thanked his competitors for their reserved personalities.

There being no new business, the meeting was adjourned at 8:30 a.m.

TREASURER'S REPORT

Thirtysecond Western Forest Insect Work Conference

Banff, Alberta, March 5, 1981

Balance on hand March 3, 1981:	(+) \$ 897.38 (CAN)
	(+) \$ 184.71 (US)
Income from Banff Conference:	
Registration (120)	(+) \$2,522.86 (CAN)
	(+) \$ 40.00 (US)
Sale of 1980 Proceedings	(+) \$ 20.00 (CAN)
Expenses of Banff Conference:	
Banff Centre Secretary	(-) \$ 45.00 (CAN)
Donation to Dinner Speaker (Canadians to Mt. Everest)	(-) \$ 100.00 (CAN)
Balance on hand March 5, 1981:	\$3,295.24 (CAN)
	<u>\$ 224.71 (US)</u>

WESTERN FOREST INSECT WORK CONFERENCE MEMBERSHIP ROSTER

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